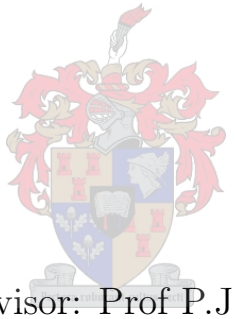
A Physical Asset Management Strategy Execution Enforcement Mechanism for the early detection and management of Physical Asset Management Strategy Execution Failure

Johann Stimie

Department of Industrial Engineering

University of Stellenbosch



Supervisor: Prof P.J. Vlok

Thesis presented in fulfilment of the requirements for the degree of Doctor of Philosophy in the Faculty of Engineering at Stellenbosch University

December 2015

Declaration

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work; that I am the sole author thereof (save to the extent explicitly otherwise stated); that reproduction and publication thereof by Stellenbosch University will not infringe any third-party rights, and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Date: 1 September 2015

Abstract

Organizations are becoming increasingly more capital– and asset intensive and spending on Physical Asset (PA)s and Asset Maintenance have been increasing steadily over the past number of decades. Organizations in general and Physical Asset Management (PAM) organizations specifically need to continuously redefine and adjust their strategies and action plans in order to increase operational effectiveness, increase revenue and customer satisfaction while reducing capital–, operating– and support cost.

Many organizations however find themselves in a strategy crisis – not because executives and practitioners are unable to develop quality strategies but because these organizations fail to execute strategies effectively. The problematic assumption that good corporate performance indicates successful Strategy Execution (SE) while poor corporate performance is an indication of unsuccessful SE complicates matters even further. Unless a clear distinction is made between organizational performance and the extent to which strategies are effectively executed the cycle of endless formulation–implementation–performance–eformulation ultimately results in attempts at implementing a wrong strategy. When this happens, it is difficult to determine if poor performance is due to good execution of a bad strategy, or the result of poor execution of a good strategy.

Despite the fact that there are clearly a number of theoretical and practical shortcomings within the exiting PAM Strategy Execution Body of Knowledge, this study aims to address the following central research problem:

> *"There is no mechanism that can assist PAM practitioners and academics with the early detection and management of Physical Asset Management Strategy Execution Failure (PAMSEF)".*

The primary objective of the study is the development of a Physical Asset Management Strategy Execution Enforcement Mechanism (PAMSEEM) to address this problem. In support of the the primary objective a number of secondary objectives are also pursued. Firstly the research aims to evaluate the existing literature on emerging approaches, themes and challenges on general business strategy. The focus secondly shifts to an in–depth analysis of contemporary contributions on SE and Strategy Execution Failure. The third secondary objectives is to distill an organizational asset classification framework and a model illustrating how assets interact to create organizational

value. The fourth secondary objective is to summarize recent developments within the PAM landscape. The fifth secondary objective is the presentation of a framework illustration the most important PAM strategy developments over the past 100 year.

The sixth secondary objective is to define Physical Asset Management Strategy Execution (PAMSE) and by implication PAMSEF and to evaluate the most recent mainstream as well as empirical and theoretical contributions regarding PAMSE and PAMSEF to juxtapose this with the insights gained during the evaluation of general business strategy formulation and SE.

Strongly grounded in the established theory of general business strategy and SE, as well as PAM strategy and PAMSE the PAMSEEM is developed thereafter. Validation of each one of the components of the PAMSEEM takes place within the context of a highly PA dependent organization. The conclusion reached at the end of the study is that the PAMSEEM when applied as recommended, will indeed assist organizations with the early detection and management of PAMSEF.

Opsomming

Organisasies word toenemend meer kapitaal– and bate–intensief. Die gevolg is dat uitgawes wat verband hou met Fisiese Bates (FB) en Fisiese Bate Onderhoud (FBO) ook aansienlik toegeneem het oor die afgelope dekade.

Organisasies in die algemeen en Fisiese Batebestuur (FBB) organisasies spesifiek is genoodsaak om voortdurend hul strategieë en aksieplanne te hersien en aan te pas in 'n poging om operasionele effektiwiteit–, verdienste–, en klient–tevredenheid te verhoog terwyl kapitaal–, operasionele– en ondersteunings–koste in toom gehou moet word.

Baie organisasies vind dit egter moeilik om wel deurdagte strategieë effektief uit te voer. Die foutiewe aanname dat goeie korporatiewe prestasie 'n aanduiding van effektiewe Strategie Uitvoering (SU) is, terwyl swak korporatiewe prestasie 'n aanduiding van oneffektiewe SU is kompliseer sake selfs nog meer. Indien 'n duidelike onderskeid tussen korporatiewe prestasie en die mate waartoe SU effektief plaasvind nie gemaak word nie, sal organisasies vasgevang bly in die formulering–uitvoering–prestasie–herformulerings siklus. Indien die onderliggende beweegredes vir strategie herformulering dus nie goed verstaan word nie, kan dié siklus maklik lei tot die implementering van 'n verkeerde strategie. Indien dit gebeur is dit baie moeilik om te bepaal of swak prestasie te wyte is aan die effektiewe uitvoering van 'n swak strategie, of die oneffektiewe uitvoering van 'n goeie strategie.

Ten spyte van die feit dat daar 'n magdom van teoretiese– en praktyk–gerigte tekortkominge is binne die bestaande FBB literatuur, poog hierdie studie om die volgende sentrale navorsingsprobleem aan te spreek:

> *"Daar is geen meganisme wat FBB praktisyns en akademici kan ondersteun om Fisiese Batebestuur Strategie Uitvoering Faling (FBBSUF) vroeg te identifiseer en teë te werk nie"*

Om die probleem aan te spreek word 'n Fisiese Batebestuur Strategie Uitvoering Afdwingings Meganisme (FBBSUAM) in die studie ontwikkel. In die strewe om hierdie doelwit te bereik word die navorsingsmetodologie wat gebruik word in die skep van teorie deur middel van gevalle studies, toegepas. Die navorsing begin met 'n evaluering van literatuur wat verband hou met die benaderings, temas and uitdagings binne algemene besigheids strategie. Hierna verskuif die fokus na 'n in-diepte analise van hedendaagse bydraes oor SU, asook onlangse verwikkelinge op die FBB landskap.

Fisiese Batebestuur Strategie Uitvoering (FBBSU) en by implikasie FBBSUF word hierna gedefinieër, en die mees onlangse hoofstroom sowel as empiriese en teoretiese bydraes aangaande FBBSU en FBBSUF word dan vergelyk met die gewaarwordinge wat duidelik geword het tydens die evaluasie van algemene besigheidsstrategie formulering en SU.

Bewapen deur 'n sterk teoretiese begronding word die FBBSUAM hierna ont–wikkel. Die validasie van elkeen van die komponente van die meganisme vind plaas binne 'n organisasie met 'n besondere hoë FB afhanklikheid. Die slotsom is dat die aanbevole toepassing van die FBBSUAM inderdaad FBB praktisyns and akademisie kan ondersteun om FBBSUV vroeg te identifiseer en teë te werk.

Acknowledgements

Vir Ma en Pa

I am an ultra-marathon runner and understand the importance of perseverance. This journey however tested my perseverance levels far beyond expectation. There are so many people who made this journey possible and that I would like to acknowledge and thank for their contribution.

- I dedicate this dissertation to my parents – Marie and Gert – through so many years of study they have been the silent force continuously motivating and providing encouragement. My mother would have been so proud.
- Professor PJ Vlok, my friend, my running partner and my supervisor (in that order). We have spend many hours running, often in the early mornings before sunrise and often very late at night long after sunset, initially through the beautiful streets of Stellenbosch and later during long inter-continental Skype calls. It was during these encounters that this study was conceptualized and refined. Later once the novelty of being a PhD candidate wore off and we got to the business side of the journey his relentless emotional and practical support assisted me over the last hills. Words cannot really describe my appreciation.
- Petrus Swart, Jarred Flynn, Elaan Coetzee and Patsy Maree were instrumental during the validation phase of the study. In the process they had to spend many hours traveling, and made their "boots dirty" during day–, night– and week–end shifts. I am most appreciative of your time and effort.
- I am deeply grateful for the management and staff of the Platinum Concentrator where this study was validated. Abraham du Plessis did not only agree to allow his staff to participate in the study, he also willingly gave of his own valuable time.
- Professor Carl van Aardt who thought me that a researcher should always remain humble;
- Last but by no means least my wife Elsje Dirks, and my dearest children Melite and Theodore. During this journey I was often physically and emotionally absent. This race is now over. Thank you for understanding. I love you very much.

"I have walked that long road to freedom. I have tried not to falter. I have made missteps along the way. But I have discovered the secret that after climbing a great hill, one only finds that there are many more hills to climb. I have taken a moment here to rest, to steal a view of the glorious vista that surrounds me, to look back on the distance I have come. But I can only rest for a moment, for with freedom come responsibilities, and I dare not linger, for my long walk is not ended."

Nelson Mandela

Contents

List of Figures

List of Tables

Acronyms and Abbreviations

$6-\sigma$ Six Sigma. ix, 63, 73, 147, 149, 164, 230

AA GTS 20 Anglo American Group Technical Standards 20. 259, 260, 262, A-2

AAC Anglo American Corporation. xxi, xxiii, 254, 255, 259–261, A-2

AAP Anglo American Platinum. xii, xxiii, 255, 257–259, 265, 276, 284, A-23

ABC Activity Based Costing. ix, xxii, 63, 68, 69, 230

AC Affective Commitment. 95

ACRG Asset Care Research Group. 139, 220, 254, 255

AKE Asset Knowledge Enablers. x, 135

AM Asset Management. x, xx, 5, 6, 122–124, 126–129, 133, 154, 155, 167, 228, 230, 261, 286, 302, A-14

AME Asset Management Engineer. 207

AMLC Asset Management Life Cycle. x, xiii, xv, xvi, xviii, 133, 134, 141, 167, 273, 286, 287, A-35

AMS Asset Management System. x, xx, 124–127

AMST Asset Management Strategy. xv, 150, A-23

ASAL Awareness, Screening, Action Planning and Learning. 194

ASMS Asset Management Standard. 259

BCG Boston Consulting Group. xix, 30

BO Bureaucratic Organization. ix–xi, 23, 26, 46, 50, 53, 54, 60, 67, 76, 78, 142, 144, 152, 154, 155, 160, 233, 240

BOK Body of Knowledge. 141, 235

BOP Blowout Preventer. 181, 182, 184

BP British Petroleum. 8, 181–184

BSC Balanced Scorecard. ix, xix, 63, 68, 71–73, 119, 163, 164, 166, 230, 309

BSM Biological System Model. xix, 50

BU Business Units. 255, 259, 261, A-2

CA Criticality Analysis. xv, xvii, A-93

CC Continuance Commitment. 95

CM Condition Monitoring. xiii, xv, xvi, 271, 287, A-45

CMT Change Management Tactics. 97–99, 179, 215, 231

CO Contemporary Organization. ix–xi, 23, 47, 48, 50, 54, 55, 67, 76–78, 142, 147, 152, 155, 156, 162, 233, 240, 241

CoE Centres of Excellence. 302, 303, A-18

CPAM Contemporary Physical Asset Management. 171, 191, 311

CQI Continuous Quality Improvement. 74

CVD Cardio Vascular Diseases. 194, 196, 197, 201, 202, 204, 205, 214, 217, 218, 234, 241, 242, 246

DD Deadly Dectet. xii, xx, 218, 219, 280

DDF Deadly Dectet Factor. xii, xxiii, 195, 214–216, 218, 220–236, 238, 243, 254, 256, 282–292, 301, 315

DE Defect Elimination. xiii, xv, xvi, 271, 287, A-29

DMAIC Define, Measure, Analyze, Improve and Control. 73, 164

DMCS Diagnostic Management Control System. xxii, 57, 58

DSS Decision Support System. ix, 62–65, 133

EPS Earning per Share. 70

ERP Enterprise Resource Planning. A-90

EVA Economic Value Add. ix, 63, 68–71, 230

FA Failure Analysis. xv, xvii, A-17

FDP Failure Defence Plan. xv, xvii, xxiv, 296, A-16

FF Five Forces. 31, 32

FIR First Industrial Revolution. 24

FW Factor Weight. 220, 222–226, 283, 289–292

GAAP Generally Accepted Accounting Principles. 37

GFMAM Global Forum for Maintenance and Asset Management. 129

GMT Group Mining and Technology. 259

GST General Systems Theory. 49, 50

HAR Human Asset Register. xxiv, 297, 298, A-21

HC Human Capital. 38, 47, 115

HR Human Resources. 36, 38

IA Intangible Assets. 37

IAM Institute for Asset Management. 6, 139, 171, 203

IMCS Interactive Management Control System. xxii, 57, 58

IO Industrial Organization. 2, 31, 40, 76

IP Intellectual Property. 116, 117

IPS In Place Score. 221–223, 283, 289

IR Intangible Resources. 36–38

ISO International Standards Organization. 5, 125

IT Implementation Tactics. 179

JD Job Description. 47, 76

JIV Joint Investigation Visit. 185

JSE Johannesburg Stock Exchange. 257

KPA Key Performance Area. 5

KPI Key Performance Indicator. 5, A-64

LCC Life Cycle Costing. A-87

LCM Least Common Multiple. 134

LI Likert Item. 139, 221, 222

LOC Levers of Control. xxii, 56, 59, 62

MAMAT Multivariate Asset Management Assessment Topograhpy. xx, 139, 140, 215, 220

MAS Maturity Score. 221–223, 283, 289

MAT Multivariate Assessment Topography. 221, 222, 282, 284–288

MC Management Control. 52–54, 62, 65

MCS Management Control System. ix, xi, 48, 51, 52, 54–56, 59, 62, 68, 69, 73, 78, 159–165, 168, 179, 180, 182, 183, 191, 214, 225, 230, 286, 312

MFOP Maintenance Free Operating Period. A-99

MGM Market Growth Matrix. xix, 29

MO Modern Organization. viii–xi, 23, 25, 44, 45, 52, 53, 76, 142, 143, 152, 159, 160

MRP Material Requirements Planning. A-38

MS Management System. 43

MTBF Mean Time Between Failures. A-98

NC Normative Commitment. 95

ND Niger Delta. xi, 184–187, 208, 209

NGO Non Governmental Organization. 185

NOPAT Net Operating Profit After Tax. 70

NOSDRA National Oil Spills Detection and Response Agency. 185

OAPEC Organization of Arab Petroleum Exporting Countries. 30, 31

OC Organizational Commitment. 96

OCMBOK Organizational Change Management Body of Knowledge. 97

OD Organizational Design. ix, xi, xv, xvii, xxii, xxiv, 43, 46–48, 54, 136, 137, 151, 155, 157, 159, 168, 179–181, 183, 186, 189, 191, 209, 214, 218, 225, 266, 285, 290, 295, 298, 312, A-9

PGM Platinum Group Metals. 257, 258

PMS Performance Management System. 60–62

PMSF Performance Management System Framework. 59–62

PPM Portfolio Planning Models. 29

PS Performance Score. 222, 223, 283, 289

PSPP PAM Systems, Processes and Practices. 287, 291

RC Role Commitment. 96

ROCE Return On Capital Employed. 2

ROI Return on Investment. 2, 68, 70

RPN Risk Priority Number. A-92

SA South Africa. 188, 189

SBU Strategic Business Unit. 72, 91

SC Strategy Control. 5, 82, 170, 179

SCM Supply Chain Management. xvi, A-38

SCM Strategy Commitment. 96

SCS Strategy Control System. ix, 48, 51, 170, 179, 180, 191, 312

SE Strategy Execution. ii, iii, viii, x, xi, 3–5, 7, 9–12, 18, 20, 21, 51, 54, 62, 79, 81–87, 89, 91–97, 99–102, 106–109, 166, 168, 170, 171, 173, 174, 177–181, 190, 191, 200, 201, 203, 214, 215, 226, 241, 245, 248, 306, 308, 311, 314, 315, A-9

SEBOK Strategy Execution Body of Knowledge. ii, x, 10–12, 20, 21, 82, 108, 109, 170, 306–308

SEF Strategy Execution Failure. xi, 10, 11, 20, 21, 71, 82, 86, 100, 170, 173, 176, 180, 181, 184, 187, 189–192, 194, 196, 197, 203, 205, 209, 212, 246, 247, 256, 299, 306, 311, 314, 315

SEG Strategy Execution Gap. 81, 85

SI Strategy Implementation. 4, 79, 81–91, 99–101, 103–105, 173, 215

SIR Second Industrial Revolution. 25, 77

SM Scientific Management. 44, 52–54, 76, 78

SMT Strategy Management Theory. viii, 23, 26

SoC Statement of Capability. A-70

SoD Statement of Direction. xiii, 198, 203, 206, 209, 211, 239, 246, 277, 278, 301

SoN Statement of Need. A-21

SoW Scope of Work. 204, 212, 242, 247

SPDC Shell Petroleum Development Company. 185–187, 208, 209

SSMT Strategy-Style Matching Theory. 92, 178

ST Self-Managed Team. 179, 302, 303

SWOT Strengths, Weaknesses, Opportunities and Threats. 28, 31

TCCM Three Component Commitment Model. 95

TFS Total Factor Score. 222–226, 283, 289–292

TIC Total Invested Capital. 70

TPC Total Possible Contribution. 222, 223, 282, 283, 289

TPM Total Productive Maintenance. 164, 165, A-99

TQM Total Quality Management. 74, 206, 244

TR Tangible Resources. 36

TRC Total Relative Contribution. 222

VCM Value Creation Maps. 119, 121, 309

WACC Weighted Average Cost of Capital. 70

WHO World Health Organization. 197, 205, 212, 213

WM Work Management. xiii, xvi, 272, 287, A-57

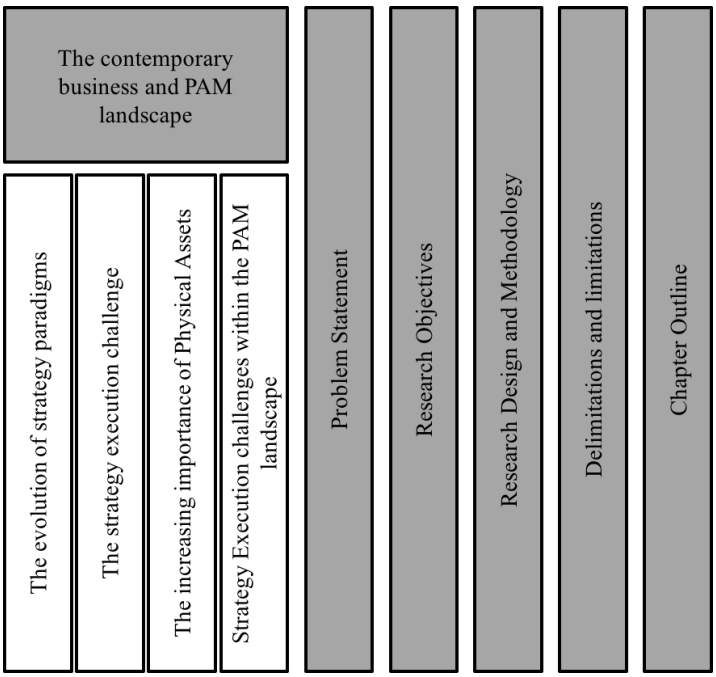
WWI World War I. 44

WWII World War II. 25, 33, 53, 77, 143, 144, 146, 153, 160

Chapter 1

Introduction and contextualization

Figure 1.1: Chapter 1 Outline



The objective of this chapter is to introduce the research undertaken. The outline of Chapter 1 is presented in Figure 1.1. The chapter commences with a brief theoretical background which leads to the research problem, the formulation of the Null Hypothesis (H_0) and the research objectives. Thereafter the dissertation scope is demarcated along with the research design and methodology followed to address the identified problem. Finally, the chapter concludes with the outline or roadmap of the study.

1.1 The contemporary business landscape

The economic and business *zeitgeist* has changed dramatically since the dawn of the new century. The radical events that shocked the financial markets of the world introduced new debates on the sustainability of not only current business models but the capitalist foundation of the world economy as a whole. In addition to the fact that the macro-economic playing field has changed dramatically over the past decade the definition of organizational success has also changed significantly. There is increased pressure on sustainability and the achievement of longer–term results and businesses the world over are no longer defining success purely in terms of the traditional measures of financial performance like Profit, Margin, Return on Investment (ROI) and Return On Capital Employed (ROCE).

Turbulence has become the hallmark of the contemporary business environment. In these uncertain times, organizations are under constant pressure to continuously enhance their capability to create value, while ensuring cost effectiveness. The focus within the contemporary organization is no longer on the definition of a grand plan, but rather the continuous generation and execution of innovative and new ideas that would surprise the competition and delight the customers. The rate of change increased dramatically and this led to the deconstruction of existing business models and strategy paradigms.

1.1.1 The evolution of strategy paradigms

Strategy paradigms evolved from a strong focus on corporate planning in the 1960's, in a time when the economy was characterized by mergers and the creation of large corporations. As organizational efficiency increased businesses increasingly embarked on diversification campaigns. This lead to the rise of so-called strategy consultants and the development of a number of portfolio planning models during the 1970's. A number of factors (not least of which the oil shocks of 1973/4) led decision makers during the early 1980's to explore the structural reasons why some industries and organizations were more profitable than others. The dominant strategy contributions in this period came from a sub-field of economics known as the Industrial Organization (IO). During the late 1980's and early 1990's the focus shifted inward. During this period the dominant discourse revolved around what Barney (1991) described as the *"resource based view of the firm"*.

The technology boom of the late 1990's – characterized by the growth of the internet, mobile telephony and digitization – led to the introduction of new thinking on strategy. Changes in the technology landscape introduced a rate of change unseen in any the foregoing periods. Theorists and practitioners alike started to questions and de-construct existing approaches and paradigms regarding not only strategy formulation but also organizational design archetypes. The existing paradigms and models were no longer adequate to support decision makers in what Ghezzi (2013) calls "the age of discontinuity".

Changes in the conception, role and deployment of employees however also had a

significant impact on the role and conception of strategy. Prahalad & Hamel (1993) is of the opinion that the strategic apex no longer exists, neither as a center of information nor as a central linking pin between the organization and its external stakeholders.

Theorists are of the opinion that the contemporary[1] paradigm rejects the positivist notion that senior managers can predict the future or that they can even dictate strategy. These contributors see top management and the formal institutions of strategic thinking at best as the creators of the context within which strategic decision are taken.

The complexities involved in the formulation of contemporary organizational strategy is well chronicled. Within the context of the recent global economic meltdown, the failure of so-called "too big to fail" corporations and a number of global corporate governance scandals, inconsistencies between intended and realized strategies have become more closely scrutinized. Many organizations however currently find themselves in a strategy crises, not because they chose the wrong strategy, but because they struggle to execute or implement the strategy.

1.1.2 The strategy execution challenge

Executing strategy throughout the organization often seem to be even more difficult than strategy formulation. In addition to Strategy Execution (SE) failures reported on in mainstream media the fact that organizations struggle to execute their strategies is also evidenced by the results of a number of empiric studies that paint a rather bleak picture on the state of SE (see Nutt (1999); Johnson (2004); Mankins & Steele (2005); Kaplan & Norton (2005); Crittenden & Crittenden (2008) and Sull *et al.* (2015)).

The intuitive assumption is that there is a strong correlation between corporate performance and Strategy Execution. Good corporate performance thus indicates successful Strategy Execution while poor corporate performance is an indication of unsuccessful Strategy Execution.

Miller (1997) however finds this correlation somewhat contentious and potentially problematic because corporate performance is the result of a range of complex and interrelated elements. Dean & Sharfman (1996) concur and state that a firm's performance is a function of a diverse array of factors. For this reason Miller (1997) is of the opinion that corporate performance is not necessarily an indication of successful Strategy Execution. These authors thus argue that in the presence or absence of good corporate performance it is critically important to understand the functioning of, and relationship between, the complex elements of a strategy. Without such an understanding it would be impossible to ensure sustainable and repeatable Strategy Execution.

Strategy non–execution occurs when the intended strategy does not meet its established goals or does not yield the predicted results, or does not operate as initially in-

[1]The contemporary strategy management period for the purpose of this study begin in 1990 (see discussion in Chapter 2).

tended or if the execution of the strategy took so long that it becomes irrelevant. In some instances strategies are implemented as intended, on time and within budget (Achievement), the strategy may also meet all predefined objectives (Completion) but is so unpopular that it cannot be acclaimed an unmitigated success (Acceptability). According to Miller (1997) the first two criteria can be viewed as somewhat more impersonal with information derived from objective information. Because of the intuitive, but problematic assumption that good corporate performance indicates successful Strategy Execution while poor corporate performance is an indication of unsuccessful Strategy Execution, poor performance is often the catalyst for strategy review and reformulation. Unless a clear distinction is made between organizational performance and the extent to which strategies are effectively executed the cycle of endless formulation-implementation-performance will ultimately result in attempts at implementing a wrong strategy. When this happens, it is difficult to determine if poor performance is due to good implementation of a bad strategy, or the result of poor implementation of a good strategy.

According to Miller *et al.* (2004) the interaction between organization and strategy, has long been treated as something of a black box. The implication is thus that it is often very difficult or even impossible for executives to identify and explain why organizations perform either good or bad.

Despite the challenges and risks posed by the non-execution of strategy there has been up to the start of the contemporary strategy management period very little deep and cohesive research on Strategy Execution. Sull *et al.* (2015) for example contend that books and articles on strategy formulation outnumber those on execution by an order of magnitude.

Theorists that have been active in recent years are however in agreement with the fact that a myriad of factors can potentially affect the process by which strategic plans are turned into organizational action. They suggest that instead of concentrating on the macro perspectives which focus on the content of strategic initiatives, the debate should shift towards more micro perspectives which emphasize how strategy is put into practice. The activity–based view of strategy proposed by Miller *et al.* (2004), argues that since managers manage strategic actions, academics and practitioners need to go inside organizations to understand what they are doing.

Strategists use interesting terminology and analogies to describe the importance of – and challenges involved in the Strategy Execution process. Some like Eisenstat & Beer (2000) and Mankins & Steele (2005) use confrontational and even sometime warfare terms such as *"dealing with strategy killers"* and *"the need to conquer the gap between strategy and performance"*. Others such as Porter & Harper (2003) use sports analogies such as *"blocking and tackling"*, and suggest that managers must *"hone their implementation skills"*. Weick (1995) believe managers should *"walk the talk"* and Simons & Roberson (2003) believe managers should show *"word–deed alignment"*. Crittenden & Crittenden (2008) are of the contention that Strategy Implementation is not an opponent that needs to be conquered or tackled. They argue that Strategy Implementation is a *"critical cornerstone and ally"* in the building of a capable organization.

It is important to note that the relatively large body of knowledge on the topic of Strategy Control should not be confused with Strategy Execution. Strategy– and Management Control Systems and processes provides important feedback (mostly after the fact), regarding the effectiveness of the strategy and most organization understand the importance of identifying and measuring Key Performance Area (KPA)s and Key Performance Indicator (KPI)s. The existence of a strategy control system is however no guarantee that strategy will be executed nor does it provide sufficient explanations on why strategies were not executed. In this study a clear distinction will be made between Strategy– or Management Control, and Strategy Execution.

1.1.3 The increasing importance of Physical Asset (PA)s

Organizations the world over are increasingly becoming more and more capital and asset[1] intensive and it has been found in various studies that spending on PAs and Asset Maintenance has been increasing steadily over the past number of decades (Tsang (2002); Dekker (1996) and Cross (1988)). Within the context of the very uncertain macro–economic landscape, the largest challenge facing these organizations, is however the necessity to maintain, and increase, operational effectiveness, revenue and customer satisfaction. Organizations need to achieve these objectives, while simultaneously reducing capital, operating and support costs (Mitchell *et al.* (2007)). The contemporary business environment has thus raised the strategic importance of the effective management of Physical Asset (PA)s.

Asset Management or Physical Asset Management has been defined by the International Standards Organization (ISO) as:

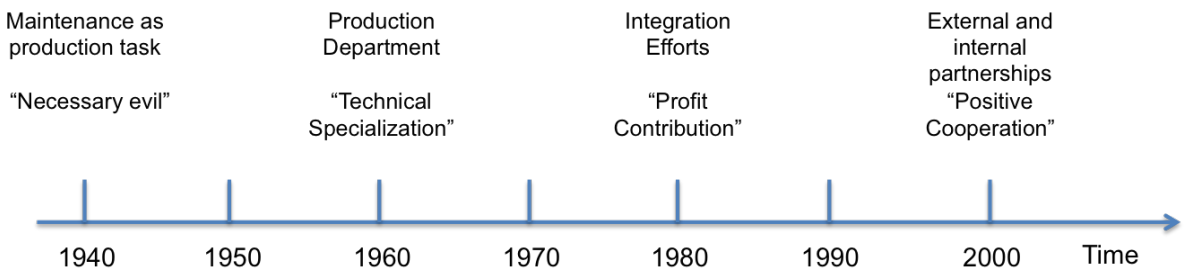
> *...the coordinated activity of an organisation to realize value from assets (where realization of value involves the balancing of costs, risks, opportunities and performance benefits)....*
>
> ISO (2014)

The opportunities for AM seem to be substantial. Indications are that industry could recover between a third and half of annual maintenance expenditure, increase production and free capital by improving AM practices. According to Penrose (2008) the size of the asset maintenance industry in the United States of America (USA) in 2005 was already $1.2 trillion of which $750 billion was as a direct result of poor AM.

The fact that organizations became more PA intensive over the years as well as the improved understanding organizations have of the potential impact effective AM practices

[1] In this study the focus will fall on the challenges and opportunities involved in the management and of Physical Asset (PA)s. Except when specifically indicated all references to assets will imply reference to Physical Assets.

Figure 1.2: Asset management time–line



Adapted from Pintelon & Parodi-Herz (2008)

can have, forced academics and practitioners, to re–evaluate and redefine their views on asset maintenance. Pintelon & Parodi-Herz (2008) developed a very useful timeline (presented in Figure 1.2) to illustrate the changing perceptions regarding the potential value of PAs within the organization over the past seven decades.

The scope of AM has thus undergone a significant shift in recent years. Amadi-Echendu (2004) refers to the *"Paradigm shift from maintenance to Physical Asset Management (PAM)"*. Amadi-Echendu (2004) is of the opinion that is since the turn of the century academics and practitioners illustrated growing interest in generalizing PAM. The generalization of PAM requires a far more strategic approach and highlights the importance of a multidisciplinary skill set, cross functionality, and targets organizational synergies. The prevalent threats, from traditional paradigms such as silo mentality and communication deficiency shifted towards an integrated view that especially emphasizes the strategic and human dimension.

The collective recognition among PAM stakeholders for the need for optimizing the mix of cost, risk and performance over the assets entire life cycle and to do so in a governable and sustainable manner, seem to be the biggest catalyst for the changes in the landscape. The recognition for the need to change led to a number of attempts in the last decade to standardize the field. These attempts led to the all important publication of the ISO 55000 standard in 2014. ISO 55000 is the the first set of international standards for asset management. In addition to the ISO 55000 standards the Institute for Asset Management (IAM) described the overall scope of Asset Management (AM). The IAM model identifies six AM subject groups. The model also highlights the fact that AM is about the integration of these groups of activities and not just the activities in isolation. The PAM focus has according to IAM, shifted from *"doing things to assets"* to *"using assets to deliver value and achieve the organizations explicit purposes"* (IAM (2011)).

1.1.4 SE challenges within the changing PAM landscape

The recognition among organizational stakeholders that the management of PAs is important and requires an integrated and strategic focus is indeed a very important development. The mere fact that organizations have a strategic intent does however not automatically lead to the achievement of strategic objectives. PAM practitioners are faced with exactly the same Strategy Execution challenges their counterparts in the rest of the business are faced with.

It was noted in Section 1.1.2 that up to the start of the contemporary strategy management period very little cohesive research has been done on the topic of Strategy Execution. It is thus not surprising to find even fewer publications dealing specifically with the challenges involved in Physical Asset Management Strategy Execution (PAMSE).

Baum & Vlok (2013) confirm this and according to them the topic of Strategy Execution is largely disregarded in the field of PAM and most PAM publications do not attempt to thoroughly analyze Strategy Execution. They contend that an enormous gap exists in the Physical Asset Management Body of Knowledge (PAMBOK) as most publications on PAM tend to focus on aspects such as asset life cycle activities, advancing new methodologies for planning and assessment, asset optimization and the use of new asset condition monitoring technologies such as non-destructive testing, transducers, vibration measurement, thermography, ferrography and spectroscopy.

Despite the fact that PAMSE is largely disregarded in academic discourse, PAM contributors have commented on the complexities and challenges involved in PAM in general. Amadi-Echendu *et al.* (2010) for example identify three characteristics of PAM that potentially has an impact on PAMSE:

These are:

- PAM is multidisciplinary since it requires the input of skills from virtually any discipline, such as engineering, information technology, economic and management;
- Decisions in PAM extend from strategic to operational and tactic aspects; and
- The human dimension of PAM requires the use of qualitative and more traditional quantitative modes of analysis.

Mitchell *et al.* (2007) identify to the following barriers to successful PAM:

- Management, organizational control and trust consistent with stated objectives of empowerment, ownership, responsibility and accountability;
- Partnership between maintenance and production;
- Full acceptance, buy-in for the PAM program at all levels of the organization;

- Full appreciation for the holistic, fully integrated processes, systems and organization necessary;
- Good communication and removal of institutional and organizational barriers to teamwork and coordination.

Finally in a rare study on the subject dedicated to the identification of the primary constraints involved in PAMSE, Baum & Vlok (2013) mapped three primary constraints:

- Overloaded key actors – refers to the fact that decision making authority is centralized in one or two key stakeholders. This reality not only stifles quick and effective decision making, it also prevents skill transfer and often lead to stakeholders burnout;
- Collaborative breakdowns – refer to the lack of cross departmental collaboration and interaction;
- Excessive intra-departmental cohesion – refers to the fact that PAM practitioners in the absence of cross departmental collaboration, often tend to become extremely self-reliant and work in very close collaboration with departmental peers. This result in the maintenance of silo's and the problems related to collaborative breakdowns are thus further perpetuated.

The impact of PAM strategy non–execution can vary from a mere *"slap on the management team wrist"*, to major loss of life, environmental damage, financial loss, and reputation damage that might take years to rebuild (if at all possible).

One of the most disturbing recent examples[1] of the potential impact of failed Physical Asset Management Strategy (PAMS) can be found in the April 2010, oil disaster in the Gulf of Mexico when a gas release and subsequent explosion occurred on the Deepwater Horizon oil rig working on the Macondo exploration well for BP. Eleven people died as a result of the accident and others were injured. At its peak in 2010, the response effort involved the mobilization of approximately 48,000 people, the coordination of approximately 6,500 vessels and the deployment of approximately 1 500 kms of boom to contain or absorb the oil. As at the end of December 2014, BP has spent more than $14 billion and workers have devoted more than 70 million personnel hours on response and clean-up activities. The US Coast Guard ended the remaining active clean-up operations in the Deepwater Horizon area of response in April 2014. If residual oil from the Deepwater Horizon incident is later identified and requires removal, BP will take action at the direction of the Coast Guard. BP shares have more than halved after the Deepwater Horizon disaster.

[1]This example as well as a number of other high profile examples of PAMSEF is discussed in more detail in Chapter 5.

An analysis of the above example clearly illustrates that the non–execution of PAM strategy undermine organizational performance and can have severe implications for the long term sustainability of the organization, its stakeholders and the environment.

1.1.5 Theoretical and practical limitations and shortcomings

The conclusion reached after assessing the literature, and while formulating the research problem, is that organizations in general and PAM organizations specifically are faced with numerous challenges spanning from strategy and policy setting to low level maintenance execution. Challenges related to strategy will for the purpose of this study be divided into two main categories:

1. *Strategy and action plan formulation challenges* – On the business strategy, action planning and governance level the contemporary business landscape requires organizations to continuously redefine and adjust their strategies and action plans in order to maintain and increase operational effectiveness, increase revenue and customer satisfaction while simultaneously reducing capital, operating and support cost. This implies that executives need to regularly rethink and re-align their position and plans regarding market segmentation, product development, product mix and market penetration and distribution.

   On the technical level PAM practitioners are required to have a far more strategic approach and need to find a balance between cost effectiveness and the management of risk and performance of the Physical Assets under their control over their entire life cycle. At the most practical level PAM practitioners need to develop plans and are held accountable for asset availability and reliability, environmental and socially responsible operations, cost effectiveness and compliance to standard operating standards and procedures.

2. *Strategy Execution challanges* – The second category of problems relate to the inability of executives and practitioners to implement and execute strategies and plans effectively and to a fundamental misunderstanding of the definition of strategy execution and the problematic and often incorrect assumption that there is a direct correlation between organizational performance and strategy execution.

The former set of challenges has been the topic of a great number of research projects and will not form part of this research project. The latter however demands more cohesive research attention, and the amount of in-depth analysis on the factors contributing to strategy non-execution seem to be far less than those focusing on strategy development and governance challenges. Those theorists that have already attempted to understand the challenge better are however in agreement that the debate should shift away from the macro perspectives which focus on the content of strategic initiatives towards more micro perspectives which emphasize how strategy is put into practice. The activity-based view of strategy proposed by Miller *et al.* (2004), suggests that since managers

manage strategic actions, academics and practitioners need to go inside organizations to understand what they are doing.

The initial review of SE literature furthermore revealed that the focus of most existing efforts to address the execution challenge, seem to be on the development of better Strategy – or Management Control Mechanisms. These mechanisms are essential and provide useful feedback when actual results are compared to strategic objectives, they are however reactionary in nature and the feedback is often too little and too late.

The above analysis highlights a number of theoretical as well as practical shortcomings within the existing SEBOK. These include:

1. The relationship between organizational performance and strategy execution are often misunderstood;
2. No clearly defined and universally accepted definition for Strategy Execution and by implication Strategy Execution Failure seem to exist;
3. Researchers have identified a number of factors leading to SEF, but very few studies seem to have explored the relationships and correlations between these factors;
4. No clearly defined and universally accepted definition for Physical Asset Management Strategy Execution (PAMSE) and by definition Physical Asset Management Strategy Execution Failure (PAMSEF) exists;
5. There is no universal agreement on the factors that lead to PAMSEF;
6. There is not mechanism that can assist PAM practitioners and academics with the early detection and management of PAMSEF.

It is of course a temptation to attempt to address all these problems. The nature and complexity of these problems would however make such an attempt both unpractical and academically irresponsible. In the light of the increasing importance of Physical Assets the focus of this study was thus tapered down. The research problem and rational of this study is presented in Section 1.2.

1.2 Research problem and rational

The aim of this study will be to address the following research problems:

Central problem:

There is not a mechanism that can assist PAM practitioners and academics with the early detection and management of PAMSEF.

Secondary problems:

1. There is currently no universally accepted definition for PAMSE and by definition PAMSEF;
2. There is no universal agreement on the factors that lead to PAMSEF.

From the central research problem, this dissertation thus will aim to reject the following null hypothesis.

H_0 *It would not be possible to develop a Physical Asset Management Strategy Execution Enforcement Mechanism that would assist academics and practitioners with the early detection and management of Physical Asset Management Strategy Execution Failure.*

1.3 Research objectives

In order to address both the central and secondary problems of this study a number of primary and secondary objectives need to be achieved.

The primary and secondary objectives are presented in Table 8.1. In Section 1.6 these objectives will be referred to again within the context of the Dissertation outline.

Table 1.2: Summary of the Research objectives

Chapter	No.	Objective
		Secondary Objectives
Two	1	Evaluate the body of theoretical knowledge on organizational strategy and the evolution of strategy formulation and present a framework for analysis.
Three	2	Define and contextualize the concept of Strategy Execution and by implication Strategy Execution Failure (SEF) Analyze the recent empirical and theoretical contributions regarding SEF and to summarize the limitationsand shortcomings of the existing Strategy Execution Body of Knowledge (SEBOK).

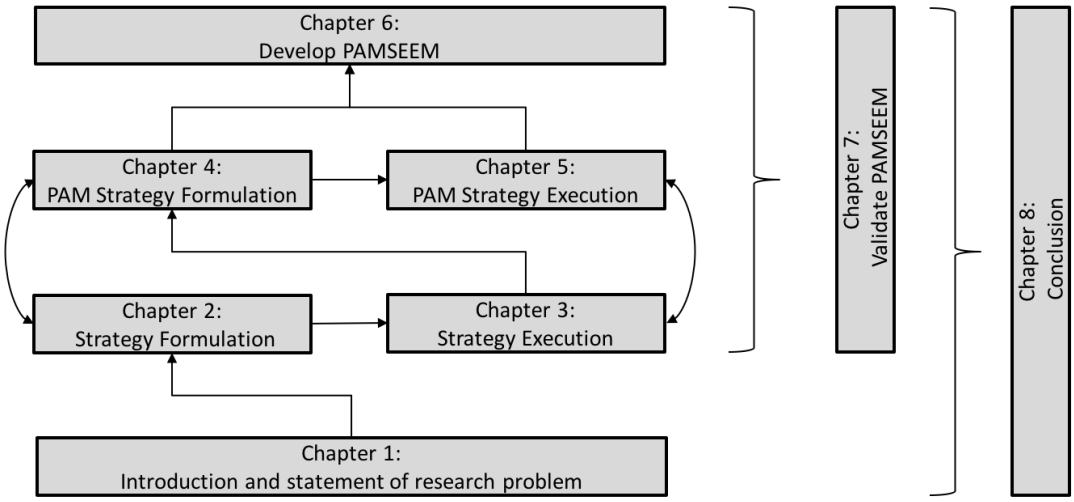
Chapter	No.	Objective
Four	3	Distill an organizational asset classification framework and develop a model illustrating how assets interact to create organizational value. An understanding of these dynamics is an essential prerequisite for the development of the PAMSEEM.
	4	Summarize of recent developments within the PAM landscape to gain an understanding of the challenges and opportunities contemporary PAM practitioners and academics are faced with.
	5	Present a framework illustrating the most important PAM strategy developments over the past 100 years within the context of the organizational strategy and within the context of contemporary strategy discourse.
Five	6	Define Physical Asset Management Strategy Execution (PAMSE) and by implication Physical Asset Management Strategy Execution Failure (PAMSEF) and analyze the recent main stream, empirical and theoretical contributions regarding PAMSE and PAMSEF, and present the limitations and shortcomings of the existing PAM SEBOK.
		Primary Objectives
Six	7	Develop a Physical Asset Management Strategy Execution Enforcement Mechanism (PAMSEEM) as well as a digestible dissemination format to address the main problem.

The objectives allow for systematically conducting the research in the form of more manageable sub-tasks. The conceptual model or roadmap illustrated in Figure 1.3 will be be used as a guide during the pursuit of these objectives.

The research process will as illustrated commence in Chapter 1 with a general introduction and the formulation of the research problem. In Chapter 2 an evaluation of the existing literature on emerging approaches, themes and challenges on general business strategy will be provided. The focus will then shift in Chapter 3 to an in-depth analysis of contemporary contributions on SE. Against the backdrop of an understanding of the challenges and shortcomings within the field of general business strategy and strategy execution, an attempt will then be made in Chapter 4 to distill an organizational asset classification framework. The aim here would be to develop a model illustrating how assets interact to create organizational value. As part of this process attempts will also be made to summarize the recent developments within the PAM landscape and to gain an understanding of the challenges and opportunities contemporary PAM practitioners are faced with. Chapter 4 will be concluded with a framework illustrating the most important PAM strategy developments over the past 100 years and these insights will be juxtaposed with the insights gained in Chapter 2.

In the next phase of the research an attempt will be made to define PAMSE and by

Figure 1.3: Research roadmap



implication PAMSEF, and to analyze the most recent main stream as well as empirical and theoretical contributions regarding PAMSE and PAMSEF and to juxtapose these with insights gained in Chapter 3.

The insights gained in all the preceding chapters would then be used to develop the Physical Asset Management Strategy Execution Enforcement Mechanism (PAMSEEM) in Chapter 6. The aim of Chapter 7 would be validate the contribution of the PAMSEEM within the context of a highly PA dependent organization. In Chapter 8 the study will be concluded with a number of recommendations for possible future research.

1.4 Research design strategy and methodology

> *"Theory, for theory's sake, can easily degenerate into an uninteresting art form. Yet, practice without theory can quickly become a dull and dangerous occupation. Unfortunately, the world is a complicated place and complicated solutions and processes are often required to make complex organizations run. The ability to live with uncertainty and the insight into both one's professional powers and limitations is the sign of a mature management science"*
>
> Shubik (1987)

Organizations are vast, fragmented and multi-dimensional and Boulding (1956) already in 1956 concluded that they are amongst the most complex systems imaginable. The impact of management research is thus highly dependent on the appropriateness and rigor of the chosen research strategy and it may well be true as McGrath (1981)

has stated that it might not be possible to do an unflawed study. Any chosen research method will have inherent flaws and the choice of method will limit the conclusion that can be drawn.

According to McGrath (1981) research strategies are generic classes of research settings for gaining knowledge about a research problem and he describes the following eight research strategies:

1. Formal theory;
2. Sample surveys;
3. Judgement tasks;
4. Laboratory experiments;
5. Experimental simulations;
6. Field experiments;
7. Field studies; and
8. Computer simulations

The researcher should however according to McGrath (1981) recognize that research design choices imply trade–offs. To highlight the trade–offs that researchers must take he refer to the *"three horned dilema"*. Various research design strategies result in:

1. More or less generalizability to the population that supports the issue of external validity; or
2. Precision in measurement and control of the behavioural variables, affecting internal and construct validity; or
3. Realism of context.

A detailed discussion of each one of these strategies falls outside the scope of this dissertation. Suffice to note that the underlying methodologies, advantages and disadvantages as well as appropriateness to address the stated research problem was considered during the development of the chosen research strategy and methodology used in this study.

The aim of this study is to evaluate and summarize the literature in the field of organizational strategy and strategy execution as well as Physical Asset Management Strategy and Physical Asset Management Strategy Execution in order to conceptualize a mechanism that will assist PAM practitioners and academics with the early detection and

management of Physical Asset Management Strategy Execution Failure, and to validate the model within the context of a highly PA dependent organization.

The methodologies involved in the *"Formal theory"* strategy seemed most appropriate to achieve this objective.

Wacker (1998) is of the opinion that although many business professionals, social scientists, and other academics have very similar beliefs on the definition of theory and according to him academics generally point to a theory as being made up of four components:

1. Definitions of terms or variables;
2. A domain where the theory applies;
3. A set of relationships of variables; and
4. Specific predictions (factual claims)

Theorist describe a number of theory building methodologies. During the development of the chosen methodology for this dissertation the work done by Eisenhardt (1989a) was found to be extremely useful.

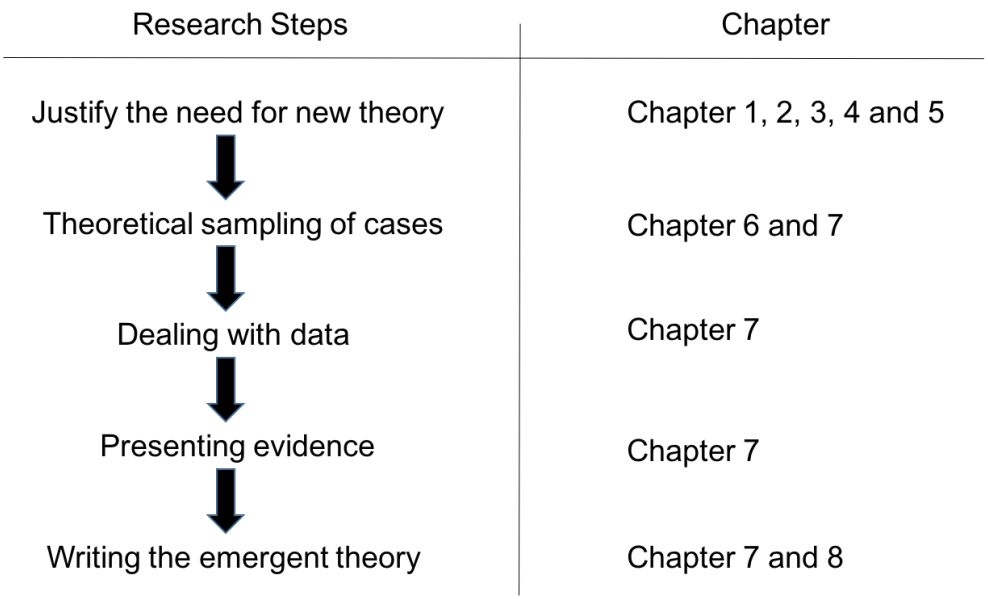
Building theory from case studies is a research strategy that according to Eisenhardt (1989a), involves using one or more cases to create theoretical constructs, propositions and/or midrange theory from case-based, empirical evidence. Case studies are according to Yin (2013) rich, empirical descriptions of particular instances of a phenomenon that are typically based on a variety of data sources.

While laboratory experiments isolate the phenomena from their context, case studies emphasize the rich, real–world context in which the phenomena occur. Theory building through case-studies is according to Eisenhardt & Graebner (2007) an increasingly popular and relevant research strategy that forms the basis of a disproportionately large number of influential studies

The underlying methodology will require the completion of the steps illustrated in Figure 1.4 and discussed in more detail in the remainder of this section.

1. Justify the need for new theory – Sound empirical research begins according to Eisenhardt & Graebner (2007) with strong grounding in related literature, where research gaps need to be identified. When using theory building from cases as a research strategy, researchers also must take the added step of justifying why the research question is better addressed by theory–building or in this case the development of a new management mechanism rather than theory-testing or in this case the evaluation of the effectiveness of existing strategy execution mechanisms. The literature grounding of this dissertation will be done in Chapters 2, 3, 4, and 5. The aim is to illustrate in these chapters that there are currently no mechanism to assist

Figure 1.4: Research methodology process map



PAM practitioners and managers to detect and manage the factors contributing to PAMSEF.

2. Theoretical sampling of case(s) – Case selection is an extremely important aspect of theory building process. In large-scale hypothesis testing research the objective is to select a sample that is representative of the population in order to be able to generalize the findings and thus support the issue of external validity (see the first horn of McGrath's three horned dilemma McGrath (1981)). The objective in theory building research is however to develop theory – not to test it – and so theoretical (not random or stratified) sampling is appropriate.

   Theoretical sampling according to Eisenhardt & Graebner (2007) simply means:

   > *... that cases are selected because they are particularly suitable for illuminating and extending relationships and logic among constructs.....in the same way laboratory experiments are not randomly sampled from a population of experiments, but rather, chosen for the likelihood that they will offer theoretical insight, so too are cases sampled for theoretical reasons...*

   According to Yin (2013) theoretical sampling of single cases is straight–forward and they are chosen because they are unusually relevant examples or provide unusual research access.

   The aim of this study is to develop a PAMSEEM and to validate it usefulness within the context of a highly Physical Asset (PA) dependent organization. In the

selection of the case or in this instance the validation context the following factors will be considered:

- The extent to which the organization is PA depenent; and
- The extent to which sufficient access to the organization and its resources can be obtained to effectively validate the newly developed mechanism.

3. Dealing with data – Case studies can accommodate a rich variety of data sources, including interviews, archival data, survey data, ethnographies, and observations. The rationale behind using multiple data sources is the same as in hypothesis testing research namely that triangulation provides stronger substantiation of constructs and hypothesis.

   In addition to the use of multiple data sources Eisenhardt (1989a) also make special mention of the use of multiple investigators during the data collection and validation process. Multiple investigators have according to her two key advantages:

   (a) They enhance the creative potential of the study; and

   (b) The convergence of observations from multiple investigators enhances confidence in the findings.

   During both the development as well as the validation of the PAMSEEM it is anticipated that reference will be made to a multiplicity of interviews with key stakeholders, analysis of a variety of documents and observations of the physical environment in which the management of PA takes place.

   It is also anticipated that the task of data collection will be completed by a team of carefully selected and competent field workers.

4. Presenting evidence – The challenge of data presentation in single-case study research is according to Eisenhardt & Graebner (2007) addressed by presenting a relatively complete rendering of the story within the text. The story typically consists of narrative that is interspersed with quotations from key informants and other supporting evidence. The story should according to them then be intertwined with the theory to demonstrate the close connection between empirical evidence and emergent theory. A number of seminal studies where this approach has been used very effectively has been referred to by Eisenhardt & Graebner (2007). The include Gersick (1994), Peters & Waterman (1982) and Eisenhardt & Brown (1998).

   In this study the PAMSEEM will be validated within the context of a highly PA dependent organization. The validation process will require both evaluation of the existing strategy execution challenges that are prevalent within the organization as well as the impact the use of the PAMSEEM had on addressing these challenges. In line with the recommendations made by Eisenhardt & Graebner (2007) these findings will be presented in the form of a narrative describing the experiences of

organizational stakeholders and the observations of the field workers. It is anticipated that ample use of verbatim quotations will be made.

Depending on the extent of these transcriptions and observations, some of the text may be included as part of an Appendix to the study.

5. Writing the emergent theory – Although the writing of the emergent theory or in this case the development of the PAMSEEM is presented as the last step in linear process of steps, it should not be construed as such. Theory building through case studies is a highly iterative process and already starts during the justification of the need for new theory. During the research process and as observations lead to new insights it is anticipated the new literature will be explored and that the scope of research may potentially widen. This is generally regarded as one of the large risks of case-study research and will be considered specifically during the course of the research process.

Against the backdrop of the research objectives as well as the chosen research strategy and methodology a number of delimitations and anticipated limitations of the dissertation are presented in the next section.

1.5 Delimitations and limitations

The previous sections outline the theoretical position of the dissertation. In exploring new areas of research it is however also necessary to state the delimitations and disclose the limitations.

The following boundaries or delimitations for the study are specifically set:

- The dissertation is bound to the field of Strategy Execution and no attempts will be made to evaluate the quality of strategic content that might be evaluated during the course of the study;
- In the development of the PAMSEEM the focus will fall on the execution of the Physical Asset Management Strategy (PAMS). Although Strategy Execution challenges might be generic, no attempts will be made to claim that the mechanism will be effective in environments outside the management of Physical Assets;

The following limitations and uncontrollable variables should also be noted:

1. Unlike empirical research where it would be possible to quantify the extent to which validation objectives are met, the nature of the validation objectives of this study require a more qualitative approach when the achievement of validation objectives are evaluated. For this reason the application impact will have to be determined amongst others, through feedback from senior organizational leadership as well as other anecdotal evidence during the validation process; and

2. In this study the impact and effectiveness of a very high-level management intervention need to be validated. The implication is two-fold:

   (a) Organizations are highly complex and dynamic environments, and it is often impossible to accurately isolate the impact of a specific intervention. With a full understanding of the dynamic nature of an organizations it would thus be important to limit the amount of time that lapse between the introduction of the PAMSEEM and the evaluation of its impact.

   (b) It is anticipated that the introduction of the PAMSEEM would required the implementation of a number of remedial actions. It normally takes a significant amount of time for the full impact of high-level management interventions to take effect, and in the light of complex and dynamic nature of organizations referred to above it may thus not be possible to observe the full long-term impact these remedial actions will have;

   As in the case with the choice of research strategy, trade-offs will have to be made in this instance as well and a balance need to be find between the amount of time that lapse between the introduction of the PAMSEEM and the evaluation of its impact, and allowing enough time for the full impact of the anticipated action plans that will be formulated as part of the operationalization of the PAMSEEM, to take effect.

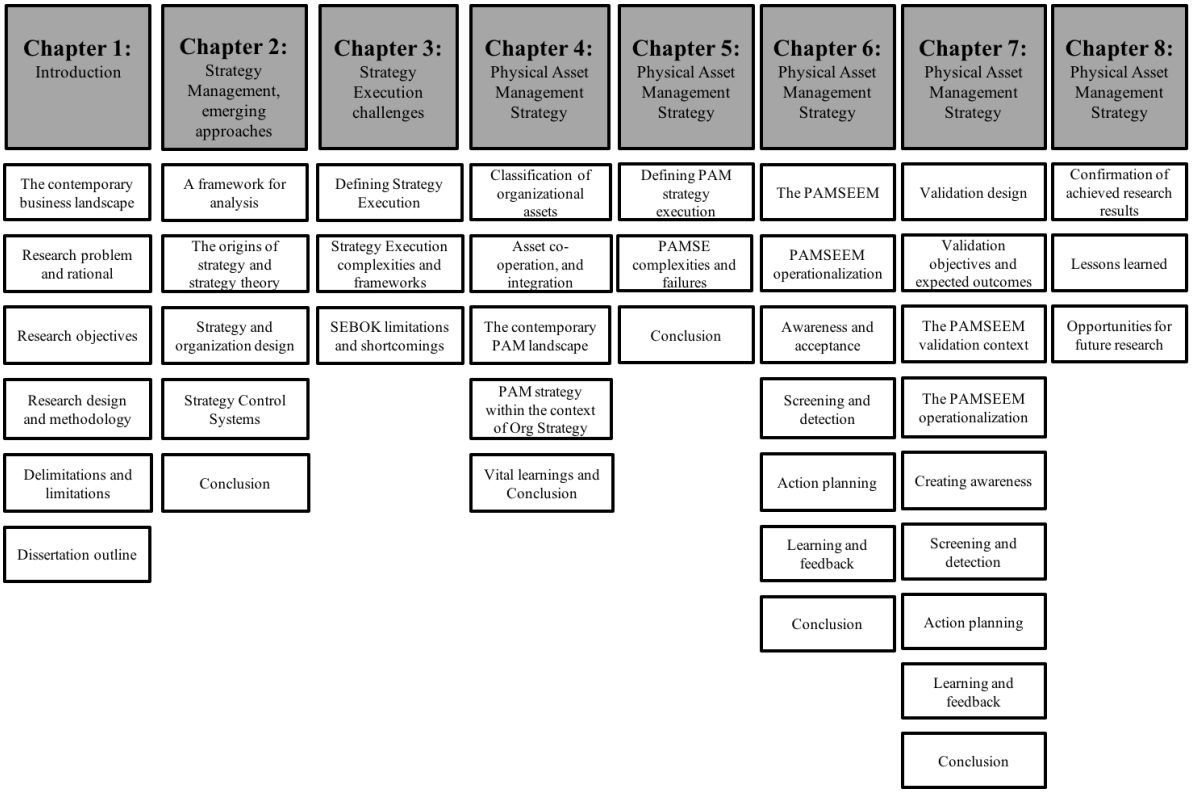
In the next section the dissertation outline will be presented.

1.6 Dissertation Outline

This section provides a summary of the dissertation content as well as the structural layout in which the content is presented. The dissertation structure is presented in Figure 1.5 and is aligned to follow the sequence of research objectives presented in Section 1.3 and corresponds to the stated research design and methodology. As a result, the reader will be able to follow the flow of the study in alignment with the progressive achievement of each research objective. This thesis is structured as follows:

Chapter 1: In the this chapter the reader was introduced to changing nature of the contemporary business landscape and the resulting evolution of strategy paradigms. Specific reference was made to the challenges organizations experience during the execution of strategy. The focus then shifted to the increasing importance of Physical Asset (PA)s as important sources of value within organizations, and thereafter the challenges involved in the execution of PAM strategies was briefly eluded to. This brief theoretical overview then lead to the identification and definition of the research problem and rational as well as the Null Hypothesis H_0, whereafter the research objectives as well as the research design strategy and methodology was explained. Against the backdrop of the research objectives and chosen research strategy a number of delimitations and limitations were then presented. The chapter is conclude with a description of the dissertation outline.

Figure 1.5: Dissertation Outline



Chapter 2: The purpose of Chapter 2 is to achieve the first objective of the study. That is to evaluate the body of theoretical knowledge on organizational strategy formulation and present a framework for analysis. In the pursuit of achieving this objective reference will be made to the following three themes:

- The origins of strategy and the development of strategy management theory;
- Strategy and organizational design; and
- Strategy and the role of Strategy– and Management Control systems.

The chapter will be concluded with the presentation of a framework for analysis.

Chapter 3: The purpose of Chapter 3 is to achieve objectives two and three of the study. That is to define and contextualize the concept of Strategy Execution and by definition Strategy Execution Failure and to analyze and summarize the limitations and shortcomings of the existing Strategy Execution Body of Knowledge (SEBOK). In the pursuit of this objective the chapter will commence with the development and presentation of a definition for Strategy Execution (SE), the most recent SE complexities,

models and frameworks will then be evaluated and the chapter will be concluded with a presentation of the most important limitations, shortcoming and opportunities identified in the SEBOK.

Chapter 4: The purpose of Chapter 4 is to achieve objectives four, five and six of the study. That is to distill an organizational asset classification framework and develop a model illustrating how assets interact to create organizational value, to summarize the recent developments within the PAM landscape to gain a better understanding of the contemporary challenges and opportunities, and to present a framework illustrating the most important PAM strategy developments over the past 100 years. In the pursuit of these objectives the following aspects will be addressed in this chapter. The chapter will commence with the development of a integrated organizational asset classification framework whereafter the co-operation, integration and interdependencies between asset classes will be highlighted. The focus will then shift to and evaluation of the contemporary PAM landscape, whereafter the developments in the PAM strategy context will be juxtaposed with developments within the general business strategy landscape. The chapter will be concluded with the presentation of a number of vital learnings.

Chapter 5: The purpose of Chapter 5 is to achieve objectives seven and eight. That is to define Physical Asset Management Strategy Execution and by implication Physical Asset Management Strategy Execution Failure and to analyze the recent main stream as well as empirical contributions regarding PAMSE and PAMSEF and to summarize and present the limitations and shortcomings of the existing PAM SEBOK. In the pursuit of these objectives the following aspects will be addressed. The chapter will commence with a definition of PAM Strategy Execution, whereafter the complexities and prevalence of PAM Strategy Execution Failure will be presented. In the presentation specific reference will be made to both international and national examples of SEF. The chapter will be concluded with a summary of the most important limitations and shortcomings identified in the PAM SEBOK.

Chapter 6: The purpose of Chapter 6 is to achieve objective nine. That is to develop a Physical Asset Management Strategy Execution Enforcement Mechanism and to present it in a digestible disementation format in an attempt to address the main identified research problem. In the pursuit of this objective the following aspects will be addressed. The chapter will commence with a brief introduction to the PAMSEEM, whereafter the proposed operationalization process will be presented. Thereafter each one of the components of the PAMSEEM will be presented in detail. This chapter will be concluded with a summary of the anticipated value contribution of the mechanism.

Chapter 7: The purpose of Chapter 7 is to achieve objective ten. That is to validate the PAMSEEM within the context of a highly Physical Asset dependent organization. In the pursuit of this objective the chapter commence with a description of the validation design and philosophy and methodology. This is an extension of the presentation of the research strategy and methodology presented in Chapter 1. Thereafter the expected outcomes of the validation process are discussed with a full recognition and understanding of the delimitations and limitations of the study presented in Chapter 1. This leads to a

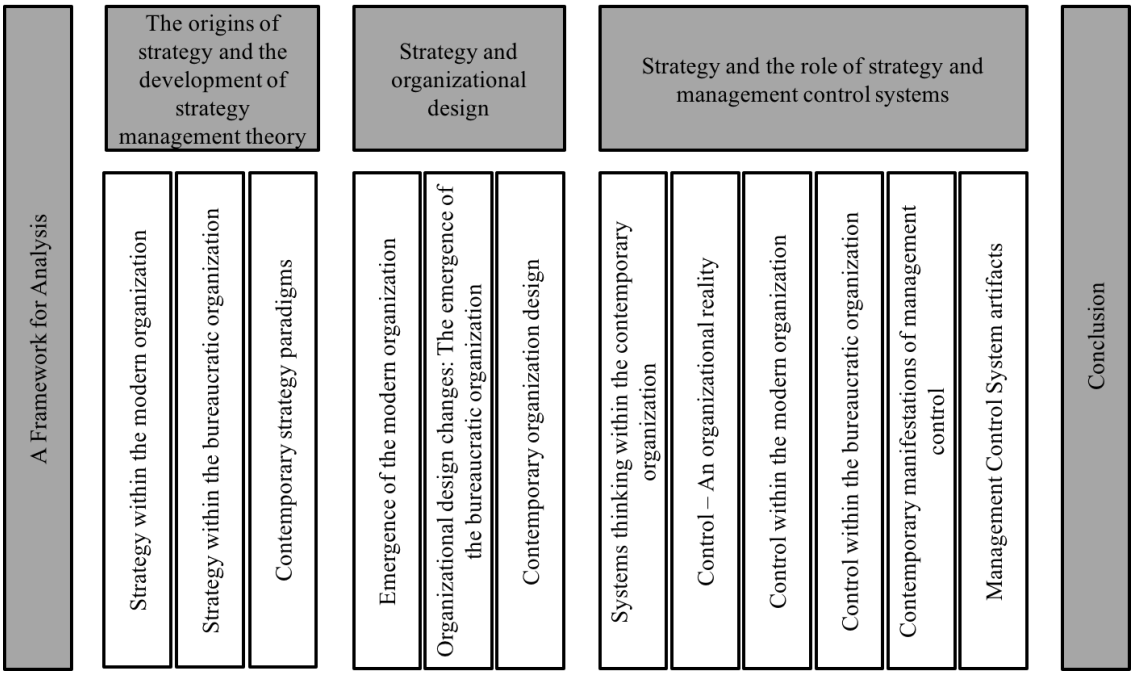
description of the chosen validation context and landscape. An abridged version of some of the most critical observations made during the research process is presented, before the PAMSEEM operationalization process is discussed in detail. The operationalization of each one of the components of the PAMSEEM is presented separately. The value contribution of each one of the components are discussed as part of the conclusion of each discussion.

Chapter 8: The purpose of Chapter 8 is to finally conclude the study. The chapter will commence with a general conclusion and confirmation of the value contribution. The focus will then shift to a number of lessons learned. The chapter will be concluded with a number of recommendations regarding possible future research.

Chapter 2

Strategy management – emerging approaches, themes and challenges

Figure 2.1: Chapter 2 Outline



2.1 A framework for analysis

The recent global recession left deep scars, and the aftermath of this crisis still takes its toll on businesses, consumers and governments. More than ever organizations need to

develop plans that would ensure competitiveness and long term sustainability. In order to evaluate the complexities involved in the formulation of a superior strategy it is important to understand the evolution of the contemporary organization. Figure 2.1 illustrates the chapter outline schematically.

The field of strategy is undoubtedly the most chronicled subject in the business world. From the huge body of information on the topic it is important to distill what is most critical for the discussion at hand. The analysis and presentation of relevant data thus poses significant challenges. After thorough analysis of emerging management literature the following categorization framework was developed. The framework consists of two components:

- Strategy Management Theory (SMT) themes:
  - The evolution of SMT;
  - Strategy and organizational design; and
  - Strategy and the role of management control systems.
- Time periods:
  - The Modern Organization (MO) (1900 – 1945);
  - The Bureaucratic Organization (BO) (1945 – 1990); and
  - The Contemporary Organization (CO) (1990 – current).

The naming conventions used for the time periods is merely descriptive and thus have no inherent significance. Other authors might describe every period in a different way or may even use different time spans to delineate the periods.

2.2 The origins of strategy and development of Strategy Management Theory

In 1935 Professor GF Gause from the University of Moscow formulated the *"Gause Principle"*(Gause (1935)). Gause (who is often referred to as the father of Mathematical Biology) published the results of a set of experiments in which he placed two very small animals (protozoans)[1] of the same genus[2] in a bottle with ample food resources. In those

[1]While there is no exact definition for the term protozoa, it is often referred to as a unicellular heterotrophic protist, such as the amoeba and ciliates. The term algae is used for micro-organisms that photo synthesize. However, distinction between protozoa and algae is often vague. For example, the alga Dinobryon has chloroplasts for photosynthesis, but it can also feed on organic matter and is motile. Protozoa is sometimes considered a sub-kingdom. It was traditionally considered a phylum under Animalia referring to unicellular animals, with Metazoa referring to multicellular animals (Alcamo & Warner (2010))

[2]In biology, a genus is a taxonomic rank used in the biological classification of living and fossil organisms. The composition of a genus is determined by a taxonomist. The standards for genus classification

instances where the animals were from a different species they could survive. In those instances were they were however from the same species they could not survive. This led to the development of the Gause Principle of Competitive Exclusion:

> *"No two species can exist that make their living in exactly the same way."*

Although competition is thus a characteristic of life itself, the natural competition within the eco-sphere however does not imply that strategy *per se* is involved. Competitors within the natural world often find combinations of resources that match their different characteristics by chance and through the laws of probability. This is according to Henderson (1989) indeed not strategy but Darwinian natural selection.

According to Wolin (1961), strategy as a concept found its first manifestation in warfare. Sun Zsu already in 400BC described the importance of a superior strategy in the battle for scarce resources between competing tribes and nations. Strategy thus has very strong military foundation and is derived from the Greek word *stratgia* that refers to the "art of leading" or the "office of general, command or generalship". The Greek verb *stratego* means "plan the destruction of one's enemies through the effective use of resources." The first reference to the word strategy in the English Language was found in 1688.

According to Bracker (1980), the concept strategy within the military context has remained important thorough history and has been used by many classical thinkers such as Shakespeare, Montisquieu, Kant, Hegel, Tolstoy and Clausewitz. The thoughts developed by these classical contributors were in turn used by many political and military leaders and theorists such as Machiavelli, Napoleon, Bismarck and Hitler.

One of the first known applications of strategy to the business world occurred when the greek businessman Nichomachides lost an election to the position of General to Antisthenes in 480 BC. Nichomachides seeked consolation from Socrates. During the conversation that followed Socrates compared the duties of a businessman and a general and illustrated that in either case one plans to use one's resources to meet objectives. This application did however not find any real traction and for many centuries the characteristics of competition within the business world were very similar to what Darwin observed within the natural world. McCraw (1997) is of the opinion that even after the First Industrial Revolution (FIR) (which spanned from the mid-1700's to the mid-1800's) no real evidence can be found of developments in strategic thinking and behaviour. The FIR was driven by development in international trade in a few commodities (especially cotton). The majority of businesses were small and owners did not invest in fixed capital. In the same way the bakers, butchers and carpenters of the medieval guild system did not require any form of real strategy planning, the small industrial and merchant firms of the FIR did not require real strategy. The market conditions were uncontrolled

are not strictly codified, so different authorities often produce different classifications for genera. In the hierarchy of the binomial classification system, genus comes above species and below family (Gill *et al.* (2005)).

and economist such as Adam Smith described market forces as an "invisible hand" that remained largely beyond the control of individual firms.

2.2.1 Strategy within the Modern Organization

According to McCraw (1997) the adoption of strategic terminology in the business context had to await the so-called Second Industrial Revolution (SIR) which only began in the second half of the 19^{th} century but really took off only in the 20^{th} century. The construction of railroads in the United States after 1850 created the infrastructure to enable mass markets. Mass markets together with access to capital and credit encouraged small business to invest in large scale fixed capital. This in turn enabled firms to exploit economies of scale in production and economies of scope in distribution.

Chandler (1969) described how these developments resulted in the "invisible hand" being replaced by the "visible hand" of a new class of professional managers.

By the late 19^{th} century a new type of firm emerged – first in the United States and later in Europe. This new firm employed far more people, made massive investments in manufacturing and marketing as well as management hierarchies to co-ordinate all functions.

Although the business eco-sphere (the Gausian Bottle – see discussion above) was changing rapidly the level of competition between between businesses species was still relatively mild (see Bracker (1980) and Henderson (1989)).

After World War II (WWII) the pace of change within the business eco-sphere started to pick up, and species suddenly experienced higher levels of competition. A Darwinian response to these changes were suddenly no longer adequate and the need for strategy in the Business World become more apparent. There are according to Ansoff (1957) two major contributing factors to the changes that occurred in the business eco-sphere after WWII:

- The marked change in pace of change within businesses; and
- The accelerated application of science and technology in the process of business management.

The increased rate of change implied that those managers that were able to predict the uncertain future better would be better positioned to develop plans and programmes to respond to these changing conditions, and to avoid the risks and threats inherent in a changing landscape.

The application of new analytical tools and techniques, such as linear programming, cost-benefit analysis, and discounted cash-flow techniques (that typically had their origin during WWII), empowered managers to make better and more informed decisions.

In addition to the pace of change and the application of technology (Henderson (1989)), is of the opinion that the revolutionary pace of change in the business eco-sphere, when compared to the natural eco-sphere, is also related to the fact that business strategist can use their imagination, and can reason logically. Imagination and logic thus make strategy possible. Without them behavior and tactics are either intuitive or the result of conditioned reflexes. Within the context of hyper competition reliance on intuition and instinct is completely inadequate. The survivors in the business world are thus not the fittest, but the most clever.

2.2.2 Strategy within the Bureaucratic Organization

For the purpose of the discussion on the development of Strategy Management Theory (SMT) within the Bureaucratic Organization (BO) the major contributions will be categorized and discussed under the following headings:

- Strategy as corporate planning;
- Diversification and portfolio planning;
- Industry analysis and competition - The need for strategic management;
- The quest for competitive advantage;
- Developing and inventory of internal resources; and
- Resource cooperation and integration.

Although these developments do not follow a strict chronological order, many of the developments in the application of strategy is the result of changes in the very nature of competition between businesses. The relationship between strategy theory development and the nature of competition between businesses is thus clearly Hegelian in nature.[1] Although the Hegelian triad is often thought to form part of an analysis of historical and philosophical progress called the Hegelian dialectic, it is often difficult to identify if changes in strategy management patterns is the result of changes in the nature of competition between business or vice versa.

Ghemawat (2001) refers in this regard to a study done by Kenneth Andrews (a Harvard Business School professor) in the late 1950's. Andrews analyzed the Swiss watchmakers industry and uncovered significant differences in performance associated with different

[1]The triad thesis, antithesis, synthesis is often used to describe the thought of German philosopher Georg Wilhelm Friedrich Hegel. The irony is that Hegel never used the term himself. The triad is usually described in the following way: The *thesis* is an intellectual proposition. The *antithesis* is simply the negation of the thesis, a reaction to the proposition. The *synthesis* solves the conflict between the *thesis* and *antithesis* by reconciling their common truths and forming a new thesis, starting the process over (Kaufmann (1978)).

strategies for firms competing in that industry. Non-performing firms soon followed the tactics employed by better performing firms. In this way the nature of competition within the industry itself changed.

2.2.2.1 Strategy as corporate planning

The first modern writers to relate the concept of strategy to business were John von Neumann and Oskar Morgenstern in 1947 (Neumann & Morgenstern (1947)). These two contributors developed a "Theory of Games". They illustrated the importance of strategy as a tool in the Corporate planning process. Although Game Theory offers penetrating insights into particular categories of the competitive situation, in terms of its application to strategic management, the overall contribution of game theory towards a better understanding of strategy has according to Grant (2010) being limited.

In this regard Andrews (1971) and Chandler (1962) are the most frequently cited. Andrews (1971) conceptualizes corporate strategy as:

> *"...the pattern of decisions in a company that determines and reveals its objectives, purposes, or goals, produces the principal polices and plans for achieving those goals,and defines the range of business. The company is to pursue the kind of economic and human organization it is or intends to be, and the nature of the economic and non-economic contribution it intends to make to its shareholders, employees, customers and communities."*

Chandler (1962) defines strategy as:

> *"...the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action with the allocation of resources necessary for carrying out these goals."*

Grant (2010) is of the opinion that the explicit interest in business strategy emerged in the United States in response to the problems of managing large, complex corporations.

These early contributors thus relied very strongly on the application of military strategy principles within the business world i.e. the optimal application of resources in an attempt reach organizational goals and objectives within the context of relatively few role-players. According to Grant (2010) the typical format of these early forms of corporate strategy plans included the following elements:

- A five-year corporate planning document clearly defined goals and objectives;
- Forecasted key economic trends (including market demand, the companies market share, revenue, costs and margins); and

- Established priorities for different products and business areas of the firm, and allocated capital expenditures.

The new techniques of corporate planning proved according to Henderson (1989) particularly useful for developing and guiding the diversification strategies that many large companies were pursuing during the 1960's.

2.2.2.2 Diversification and portfolio planning

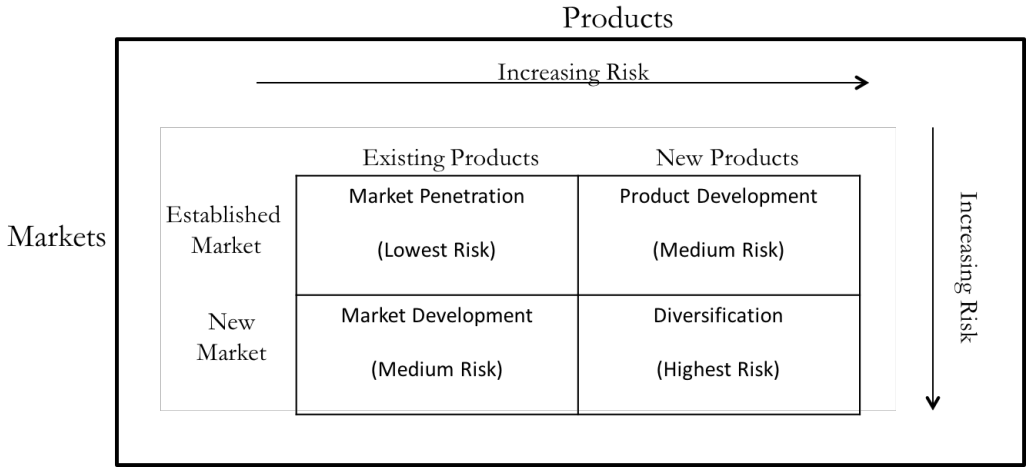
As organizational efficiency increased (the result of improved corporate planning), business increasingly embarked on so-called diversification campaigns. Growth became the biggest driving force within the business eco-sphere. Ries (1992) notes that businesses were driven by demands for substantial increases in annual sales and profits. According to Grant (2010), growth in this time (and still is today) a powerful motivation for senior managers and for employees in general. Growth created opportunities for promotion and salary increases. Status within the organization was however typically more dependent on the size of the enterprise than its profitability. These diversification strategies manifested in many ways, including increased varieties and flavours, branching out into other markets, acquisition of other products and firms or setting up joint ventures.

These diversification strategies also had many names – some companies referred to "exploiting synergies", others "line extension". A detailed analysis of the success of these strategies falls outside the scope of this study – suffice to say that there are ample examples of companies that embraced these diversification strategies only to destroy huge value despite a seemingly large growth in turnover (Ries (1992)).

The diversification efforts however introduced new levels of complexity and decision makers thus required new strategy models and aids. During this phase of strategy development there were increasingly high expectations for the application of computer technology. Consulting groups developed so-called market– and portfolio life cycle matrices. These were useful conceptual models and frameworks assisting managers to deal with increased complexity. In the next section the focus will fall on three of these frameworks that are still used during strategy analysis and planning.

The SWOT framework One of the first strategic aids to gain real traction was the so-called Strengths, Weaknesses, Opportunities and Threats (SWOT) framework. During the 1960's class room discussion in various business schools came to focus on matching a companies strengths and weaknesses – it's internal competencies with the opportunities and threats that it faced in the business eco-sphere. The SWOT framework is still used as a simple strategic planning aid, especially when managers need to define the firms distinctive competence (Ghemawat (2001)).

Figure 2.2: Ansoff Market Growth Matrix



Reproduced from Ansoff (1965).

Market Growth Matrix (MGM) Ansoff (1957) developed a MGM. The matrix is presented in Figure 2.2. The matrix suggest four different market expansion strategies:

Market penetration This refers to growth in market share within existing market segments. This can be achieved by selling more products/services to established customers or by finding new customers within existing markets.

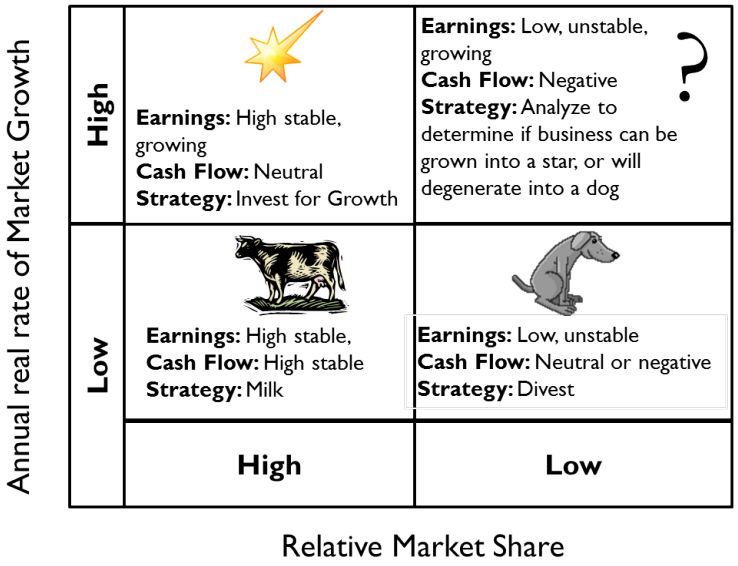
Product development This involves developing new products for existing markets. Product development involves thinking about how new products can meet customer needs more closely and outperform the products of competitors.

Market development This strategy entails finding new markets for existing products. Market research and further segmentation of markets helps to identify new groups of customers.

Diversification This involves moving new products into new markets at the same time. It is the most risky strategy. The more an organization moves away from what it has done in the past the more uncertainties are created. However, if existing activities are threatened, diversification helps to spread risk.

Portfolio Planning Models (PPM) Portfolio analysis is according to Grant (2010), probably the best know and widely applied technique of strategy analysis ever developed. The basic idea is to represent the various businesses within the diversified organization within a simple graphic framework that can assist with the formulation of strategy. A number of these frameworks have been developed over the years. For the purpose of this analysis the focus will only fall on the framework developed by Henderson on behalf of

Figure 2.3: BCG Growth Share Matrix



Reproduced from Grant (2010).

the Boston Consulting Group (BCG) in 1970 (see Henderson (1979)).

The BCG Growth Share Matrix is presented in Figure 2.3. According to Ghemawat (2001), BCGs strategic recommendation was to maintain a balance between "cash cows" and "stars", while allocating some resources to "question marks". BCG recommended that firms should disinvest in "dogs".

Managers and companies indeed show the value in the use of these relatively easy to use strategic planning aids. A survey of Fortune 500 industrial companies concluded that by the end of 1979, 45% of firms used some type of portfolio planning technique (see Haspeslagh (1982)).

2.2.2.3 Industry analysis and competition – The need for strategic management

Ghemawat (2001) is of the contention that the same macroeconomic conditions that increased the popularity of portfolio analysis also inspired questions regarding the use of the techniques. The oil shocks[1] of 1973/4 disrupted the macro-economic stability. There was

[1]Accoring to Yergin (2011), the 1973 oil crisis started in October 1973, when the members of Organization of Arab Petroleum Exporting Countries (OAPEC) (consisting of the Arab members of Orga-

growing evidence on the failure of diversification and the drive towards conglomeration slowed significantly. The world entered a period of intense turbulence and many firms were forced to abandon their medium term corporate plans in favour of more flexible approaches to strategic management.

US firms came under severe pressure across a wide range of world industries – from steel to banking. The focus according to Grant (2010) shifted away from planning and diversification towards the need for competitiveness. In this period top management's perception regarding it's role also gradually evolved from "corporate planners" to "strategic managers".

Grant (2010) is of the opinion that the emergence of "strategic management" was associated with three distinct themes:

- A concern with building competitive advantage, by combining environmental analysis with assessment and development of internal resources. Initially management teams used the SWOT framework, and later the Five Forces framework after it's publication 1980. See discussion of the Five Forces framework below;
- An embracing of more flexible approaches to planning and a rejection of detailed corporate plans; and
- Disillusion with so-called "corporate planning departments", strategy formulation became a key responsibility of the same managers who were responsible for its execution.

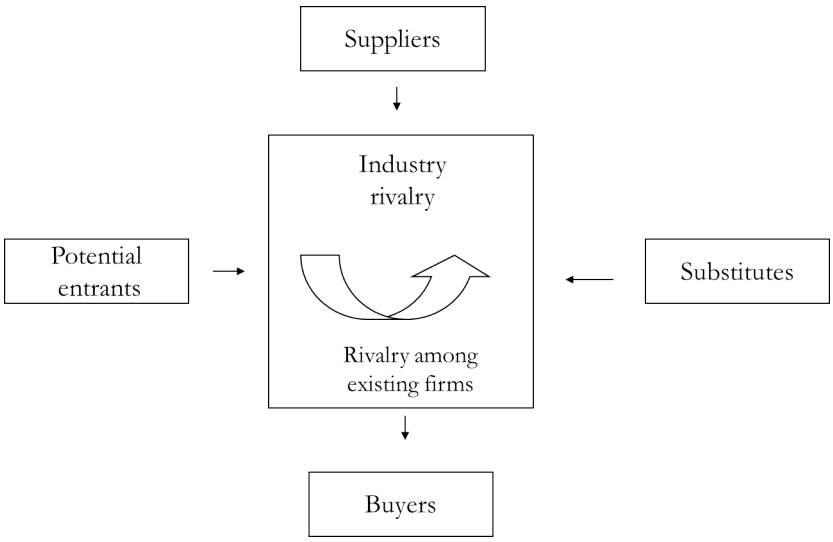
During the late 1970's and early 1980's the increased awareness of the external environment led to the growth of a sub-field of economics, know as Industrial Organization (IO), that explored the structural reasons why some industries were more profitable than others (Grant (2010)).

Michael Porter of the Harvard Business School pioneered the application of IO economics for analyzing determinants for firm profitability. In 1980 he published his first book, *"Competitive Strategy"*. In this book he introduced the Five Forces framework (Porter (1980)).

The framework is presented in Figure 2.4. The framework views the profitability of an industry as determined by Five Forces of competitive pressure. These FF include three sources of horizontal competition:

nization of Petroleum Exporting Countries (OPEC), plus Egypt, Syria and Tunisia) proclaimed an oil embargo. In the Yom Kippur War of that year, Egypt and Syria, with the support of other Arab nations, launched a military campaign against Israel on the holiest day of the Jewish calendar in order to regain Arab territories lost to Israel in the 1967 Six Day War. The United States chose to re-supply Israel with arms and in response, OAPEC decided to retaliate, announcing an oil embargo against Canada, Japan, the Netherlands, the United Kingdom, and the United States. It lasted until March 1974. The result of the embargo was that the oil price at the time quadrupled to nearly $12/barrel.

Figure 2.4: The Five Force Framework



Reproduced from Porter (1980).

1. Competition from established industry role players;
2. The threat of competition from new entrants; and
3. Competition from substitutes;

and in addition to the above there are also two sources of vertical competition:

4. The bargaining power of suppliers; and
5. The bargaining power of buyers.

In the next section each of these Five Forces will be briefly discussed.

Rivalry between established competitors: The degree of rivalry between established competitors (the same species in Gausian Botlle), is according to Ghemawat (2001) the most obvious of the five forces model and the one that most strategists have traditionally focussed on. There are numerous structural determinants of the degree of rivalry within an industry. The first of these concerns the number and relative size of competitors. The more concentrated the industry the more likely it is that competitors will restrain their rivalry. If one the other hand there are numerous competitors the rivalry will be far more intense. For similar reasons the presence of one dominant player as opposed to multiple smaller and equally sized players will tend to restrain rivalry.

Ghemawat (2001) compares in this regard the profitability of the steel industry in the United States before and after WWII. The industry was clearly far more profitable before the war. Ghemawat is of the opinion that this is a result of the nature of the steel industry structure before and after the war. Before the war the industry was characterized by a small number of players, with U.S. Steel being the clear dominant player. U.S. Steel used a number of methods (some legal some not entirely legal) to ensure price stability. These methods included clandestine meetings with other role-players during which pricing policies were discussed. U.S. Steel like major players in a number of other industries thus ensured that prices remained artificially high. After the war many more players entered the market and U.S. Steel lost its dominant position. Steel prices thus came down which in turn resulted in lower levels of profitability.

The other major factors determining the nature and intensity of competition between established firms are:

- Diversity of competitors;
- Product diversification;
- Excess capacity and exit barriers; and
- Cost conditions.

A detailed discussion of each of these factors falls outside the scope of this study.

Threat of entry: The second horizontal force mentioned by Porter (1980) is the threat of new entrants to a given industry. Grant (2010) contends that an industry that earns a return on invested capital in excess of its cost of capital, will be highly attractive and will inevitably attract firms from outside the industry. Unless the entry of new firms is regulated or barred in some way, the profitability will reduce as more role-players enter the industry. It may however not even be necessary for entry to take place, the mere threat of entry may be sufficient to ensure that established firms constrain their prices to the competitive level. The principal sources of barriers to entry are:

- Capital requirements;
- Economies of scale;
- Absolute cost advantage;
- Product differentiation;
- Access to channels of distribution;
- Legal and regulatory barriers; and

- Retaliation.

A detailed discussion of all these sources fall outside the scope of this study. See Grant (2010) and Ghemawat (2001) for a detailed discussion.

Competition from substitutes: The third horizontal force relates to the extent to which the threat of substitutes constrains industry pricing.

The nature and extent of threat of substitutes is determined by the following factors:

- The propensity of buyers to substitute – are there close substitutes for the service, and how willing are customers to shift their purchases on the basis of changes in relative prices. The critical issues is the willingness to substitute; and
- The price-performance characteristics of substitutes – the willingness of customers to switch between substitutes in response to price changes depends on their relative performance in relation to price.

Grant (2010) refers in this regard to the substitution of aluminium for steel in the metal can industry. Despite the higher cost of aluminium its lighter weight and lithographic characteristics made it more attractive for the metal can industry. The higher cost did initially slow down the substitution process, but very few examples of steel being used within contemporary metal can manufacturing processes can be found. Aluminium thus substituted steel completely within this industry.

Bargaining power of buyers: Buyer power is the first of the two vertical forces that influence the value created by an industry. Buyer power is according to Ghemawat (2001) influenced by a number of factors including:

- Buyer concentration;
- Buyer volume;
- Switching cost;
- Buyer information;
- Buyer profits;
- Brand identity;
- Ability to backward integrate; and
- Decision makers incentives.

Buyer size or volume and concentration are most probably the most important determinants for buyer power (Ghemawat (2001)). A classical example is the strong bargaining position auto makers has in their relationship with steel manufactures. The contrary is however also true. For a very long period there were no substitutes available for the patented drug Viagra. Buyer thus had to buy from a specific manufacturer. Even in instances were therapeutic substitutes were available slight differences in chemical composition can yield significance deviation in product performance (Ghemawat (2001)).

Bargaining power of suppliers: The second vertical force is the power of suppliers. According to Grant (2010) the analysis of the determinants of relative power between producers and suppliers is exactly analogous to the analysis between producers and buyers.

Ghemawat (2001) refers in this regard to the way in which the suppliers of labour influenced profitability within the U.S steel industry in the period 1978 to 1996. The majority of workers within this industry belonged to the United Steel Workers Union. Through collective bargaining these suppliers of labour have been able to negotiate salaries and wages far in excess of the midpoint in other related industries while protecting jobs. The impact of this phenomenon was that excess compensation and labour cost reduced steel maker revenues by up to 25%.

2.2.2.4 The quest for competitive advantage

> *"If a man make a better mousetrap than his neighbor, tho' he build his house in the woods, the world will make a path to his door."*
>
> –Ralph Waldo Emerson (attributed)

Until the late 1980's most developments in strategy analysis focused on the industry environment of the firm and it's competitive positioning relative to rivals. The strategic analysis of the firm's internal environment remained largely underdeveloped. Internal analysis, including the development of the ideal organizational structure, systems of control and management style was viewed as a consequence of the adopted strategy and was thus not regarded as a source(s) of competitive advantage (Grant (2010)).

Since the late 1980's there has however been a significant focus on the role of internal resources and capabilities as the basis for strategy and determinant for profitability. Barney (1991), described the *"resource based view of the firm"*. According to Barney the traditional departure point for formulation of strategy is the "mission statement". The mission statement seeks to answer the question "What is our business?". Up until the late 1980's the answer to this question would have been found by asking the questions regarding customer needs and preferences. Exponents of the "resource based view of the firm", is however of the opinion that within the context of volatile customer expectations

and a dynamic external environment, the firm itself, in terms of its resources and capabilities, may be a far more stable basis to define it's identity and offer a more durable basis for strategy.

A classical example of a company that mistakenly used shifting industry and technology trends as the basis for strategy formulation as opposed to internal resources and capabilities was Olivetti, the Italian typewriter and office equipment company. The microcomputer revolution of the late 1970's and early 1980's left traditional typewriter producers with two strategic alternatives. The first alternative was to acquire new electronic technology to continue to serve the word processing needs of their clients, or to use existing resources and capabilities in terms of brand name, engineering skills and plant and deploy them in the manufacturing of other office equipment such as printers. Olivetti chose the former and invested heavily in establishing itself as a Personal Computer manufacturer, but achieved far less success than other companies such as Brother that chose to define their identity in terms of it's internal resources (Grant (2010)).

While conventional approaches to competitive advantage focus upon so-called "generic" sources of competitive advantage – namely, cost and differentiation advantage, the resource based view of the firm focus upon the resources and capabilities that underlie these advantages. The implication is thus that the decision makers within an organization need to:

- Develop an inventory of internal resources; and
- Understand how these resources work together to create competitive capabilities.

2.2.2.5 Developing an inventory of internal resources

The development of an internal resource inventory proofs to be more difficult than anticipated and traditional balance sheets often provides only a partial and distorted view of the firms total assets. Most accounting and management information systems does not provide an accurate inventory of all organizational resources (Grant (2010)).

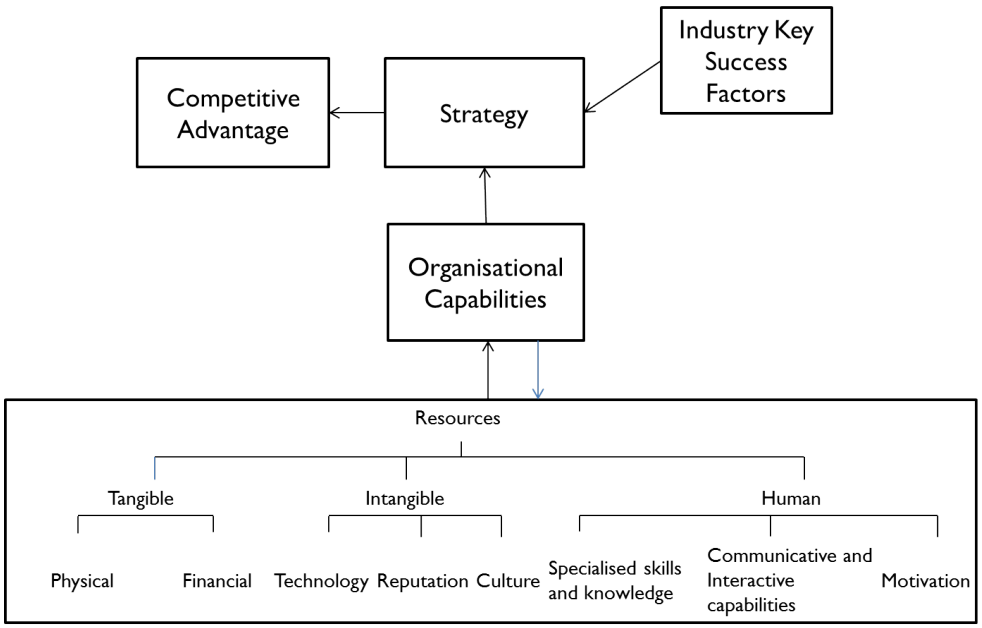
Figure 2.5 illustrates a simple classification model developed by Grant (2010).

In the model he makes a distinction between three major types of internal resources:

- Tangible Resources (TR);
- Intangible Resources (IR); and
- Human Resources (HR).

Tangible Resources – are the easiest to identify and evaluate. These resources typically include financial resources and physical assets. They are noted in the firms

Figure 2.5: Resource based view of the firm



Reproduced from Grant (2010).

financial statements, but due various reporting principles such as the Generally Accepted Accounting Principles (GAAP), that determine the rate at which Physical Asset (PA) can for example be devalued for tax purposes, balance sheets often obscure the true strategic value of this asset class (Grant (2010)).

Intangible Resources – remains largely invisible in terms of the organizations financial statements. On most balance sheets Intangible Resources (IR) or also referred to as Intangible Assets (IA) are typically referred to as "goodwill" and capitalized Research and Development (R&D). In many instances the true value of a company may thus be both invisible and non-obvious. According to Grant (2010) the first form of Intangible resource is technology. An important issue in evaluating technological resources is ownership. Proprietary technology comprise patents, copyrights and trade secrets. The ongoing legal battle between Apple and Samsung regarding the design of smartphones and tablet computers is a classical example of the importance of technology as a source of intangible competitive advantage[1].

[1]Apple Inc. v. Samsung Electronics Co., Ltd. was the first of a series of ongoing lawsuits between Apple Inc. and Samsung Electronics regarding the design of smartphones and tablet computers (Bajwa (2014)). The companies made more than half of smartphones sold worldwide as of July 2012. In the spring of 2011, Apple began litigating against Samsung in patent infringement suits. Apple's multinational litigation over technology patents became known as part of the mobile device "smartphone patent wars".

The second group of IR is reputation. Reputation may be attached to both the company (e.g. Marks & Spencer earned a reputation for quality products and customer service) or the products produced by the company (e.g. Nestle's bid price exceeded the book value of Rowntree by more than 500% when the acquisition took place in 1988. Analysts were of the opinion that this was a direct result of the strong brands such as *"Kit Kat"* and *"After Eight"* within Rowntree at the time) (Grant (2010)).

The third group of IR is organization culture. Barney (1986), is of the opinion that culture might be one the most important sources of competitive advantage. He refers to attempts made by various scholars to explain the sustained financial performance of companies such as IBM, Hewlet Packard and Proctor and Gamble. In all these studies the focus fell on the managerial values and beliefs embedded within the respective organizational cultures. Barney (1986) concludes that firms with sustained superior financial performance typically are characterized by a strong set of core managerial values that define the ways they conduct business. It is these core values (about how to treat employees, customers, suppliers, and others) that foster innovativeness and flexibility in firms. When they are linked with management control, they are thought to lead to sustained superior financial performance.

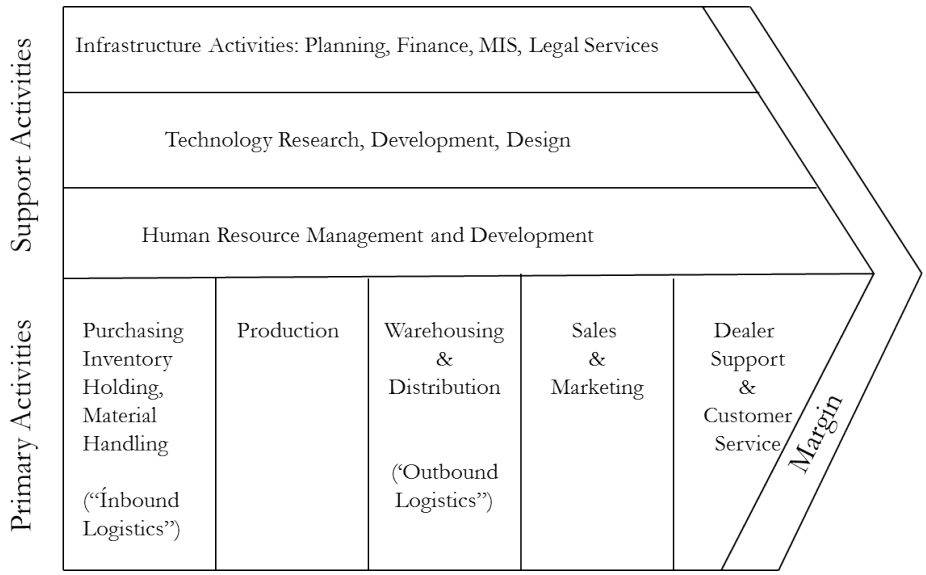
Human Resources (HR) – In economist's terminology the productive capability of human beings are referred to as Human Capital (HC). Identifying and appraising the stock of HC in an organization is however complex. The assessment of skills, qualifications and experience is relatively easy but these are only indicators of potential and thus not really predict true performance. The performance prediction problem is further exacerbated by the fact that people typically work in groups or in teams. In the same way a group of high potential sports men and women may produce sub-standard results if the team dynamics are not conducive, high potential individuals within the work context might produce sub-standard results because of non-optimal team dynamics (Barney (1991)).

Progressive organization are thus increasingly recognizing that in the evaluation and development of Human Capital inventories it is not just individuals' expertise and knowledge that is important but the firms ability to ensure that these resources are brought together to function as an integrated whole (Grant (2010)).

2.2.2.6 Resource cooperation and integration

Resources are not normally productive on their own. Leadership teams need to actively intervene to ensure the optimal cooperation and integration of resource within the organization. The best performing organizations are normally those that understand their unique abilities the best. Selznick (1984) refers in this regard to the organizations "distinctive competence". Distinctive competence describes those things that the organization does particulary well in relation to its competitors. Prahalad & Hamel (1993) coined the term "core competence" to distinguish those capabilities that are more important to a

Figure 2.6: The Porter Value Chain



Reproduced from Porter & Millar (1985).

firms success from those that are less important.

Both these terms focus the attention on the issue of competitive advantage. The importance is thus not the organizational capabilities *per se* but the capabilities relative to that of the competition.

Porter & Millar (1985) developed a classification (the "Porter Value Chain") to assist organizations to distinguish between primary and secondary activities. The Porter Value Chain is presented in Figure 2.6.

Primary activities typically involve the transformation of inputs and interface with the customer. Secondary activities are normally supportive in nature. In order to sustain a position of competitive advantage an organization need to understand its primary activities and ensure high levels of relative competence within these activities. The organization also need to understand the relationship between these activities.

2.2.3 Contemporary strategy paradigms

> *"We are a big fish that has been pulled from the water and is flopping wildly to find its way back in. In such a condition the fish never asks where the next flip or flop will bring it. It senses only that its present position is intolerable and that something else must be tried".*
>
> Chinese Saying – quoted by Thurrow (1996).

.

In the discussion above the major developments in the field of strategy management over the past five decades were briefly evaluated. It was illustrated that changes in the external environment had an impact on the way in which strategy was conceptualized. Strategy paradigms evolved from a strong focus on corporate planning in the 1960's, in a time when the economy was characterized by mergers and the creation of large corporations. As organizational efficiency increased businesses increasingly embarked on diversification campaigns. This lead to the rise of so-called strategy consultants and the development of a number of portfolio planning models during the 1970's. A number of factors (not least of which the oil shocks of 1973/4) led decision makers during the early 1980's to explore the structural reasons why some industries and organizations were more profitable than others. The dominant strategy contributions in this period came from a sub-field of economics know as the IO. During the late 1980's and early 1990's the focus shifted inward. The dominant discourse during this period revolved around what Barney (1991) described as the "resource based view of the firm".

The technology boom of the late 1990's – characterized by the growth of the internet, mobile telephony and digitization – led to the introduction of new thinking on strategy. The changes in the technology landscape introduced a rate of change unseen in any the foregoing periods. Theorists and practitioners alike started to questions and deconstruct existing approaches and paradigms regarding not only strategy formulation but also organizational design archetypes. The existing paradigms and models were no longer adequate to support decision makers in what Ghezzi (2013) calls "the age of discontinuity".

Changes in the conception, role and deployment of employees however also had a significant impact on the role and conception of strategy. Prahalad & Hamel (1993) is of the opinion that the strategic apex no longer exists, neither as a center of information nor as a central linking pin between the organization and its external stakeholders. It is interesting to note that Peters & Waterman (1982) in their seminal work *"In search of Excellence"* already in 1982 started to question the well accepted ideas of Taylor and Fayol regarding the division of labour. It would not be accurate to call their ideas contemporary but their ideas did make a significant contribution to the development of contemporary thinking regarding strategy.

Stacey (1991) is of the opinion that the contemporary paradigm rejects the positivist notion that senior managers can predict the future or that they can even dictate strategy. Contemporary theorists see top management and the formal institutions of strategic thinking at best as the creators of the context within which strategic decision are taken.

In this regard Mintzberg (1994) is of the opinion that the development of contemporary strategy is often co-incidental, implying that it is done without the conscious intention of senior management:

> *"...some of the most important strategies in organizations emerge without*

the intention or sometimes awareness of top managers. Fully exploiting these strategies, though, often requires that they be recognized and then broadened in their impact... It is obviously the responsibility of managers to discover and anoint these strategies..."

Eisenhardt & Brown (1998) refer to this paradigm as "competing on the edge". These authors are of the contention that traditional strategy paradigms focus on the development of long-term defensible positions or sustainable competitive advantages. These strategy formulation paradigms are defined (as described above) in terms of a generic strategic position like low cost or differentiation, or in terms of two or three specific core competencies around technologies, brands, or organizational skills.

A "competing on the edge" strategy is in contrast, dynamic, short term, often complicated and unpredictable. In this regard Eisenhardt & Brown (1998) refers to the strategic approach followed by Intel (the world leading manufacturer of semi-conductors). Intel has about 90% of the semi-conductor market share. The organization has both strong manufacturing capability as well as technological leadership. The focus of the management teams are however not at all defensive. Managers are continuously encouraged to create a series of unpredictable and complicated advantages ranging from bleeding edge technology for multimedia to innovative branding campaigns such as *"Intel Inside"*.

Intel managers truly believe that their advantage is temporary and that their strategy must be constantly shifting and evolving in ways that surprise and confound the competition.

There has thus been a shift in emphasis from "strategy as detailed plan" to "strategy as broadly defined direction". Liedtka (2001) calls this process "generative strategic planning". Her model is represented in Figure 2.7.

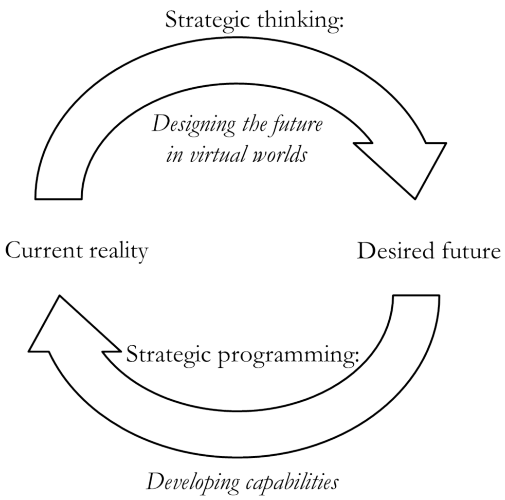
The model describes strategy formulation as a process in continuous motion, as the gap between current reality and future intent is broadened and subsequently narrowed through the interaction of the new possibilities that the organization envisions in its virtual world and the new capabilities that it develops in its actual world.

According to the model strategic change begins with a cognitive framework, in the minds of managers, with the creation of a gap between their view of the current reality and an image of a future to which they aspire.

If this creative gap does not exist managers would not have any real motivation to change. The model requires that managers are both creative and analytic. The strategy formulation process is thus emergent, complex and involved (Liedtka (2001)).

The differences between traditional and generative strategy formulation are summarized in Table 2.1

Figure 2.7: A model of generative strategic planning



Adapted from Liedtka (2001).

Table 2.1: Traditional versus generative planning model

	Traditional	**Generative**
Primary purpose of planning	• Coordination and control • Creation of the plan	• Strategic change • Development of strategic thinking
Level of involvement	• Limited primaraly to senior and division managers	• Broadly inclusive of diverse members at all levels
Nature of involvement	• Through written communication directed upward • Advocacy mode	• Dialogue-based • Advocacy and inquiry mode • Hypothesis-driven
Timing	• Periodic • Calendar-driven	• Episodic • Issue driven
Competencies required	• Analytic	• Alternative generation and evaluation • Conflict resolution

	Traditional	Generative
Leadership role	• Strategic thinker • Decision originator	• Process enabler • Synthesizer
Contextual elements	• Clarity in providing objectives and planning guidelines	• Clarity of purpose organizational • Sense of urgency • Psychological safety

Adapted from Liedtka (2001)

From the above it is clear that the challenge faced by contemporary organizations is thus no longer the definition of a grand plan, but rather the continuous generation of innovative and new ideas that would surprise and confound the competition and delight customers and potential customers.

The nature of contemporary strategy formulation however also implies a realignment of behavioural and power dynamics within the organization. It would thus be impossible to fully comprehend the challenges faced by contemporary managers regarding the achievement of strategic and organizational goals without a proper understanding of the emergence of organizational design and management systems. The changing nature of Organizational Design and Management Systems are discussed in detail in the two next section.

2.3 Strategy and Organizational Design

> *"Ultimately, there may be no long-term sustainable advantage other than the ability to organize and manage"*
>
> Lawler & Mohrman (2000)

Initially theorists argued that Organizational Design (OD) and Organizational Structure was the result of environmental, technology and strategy changes. Later theorists argued that it was important to understand the congruence between strategy and structure and other Management Systems rather than identifying the causal relationships between strategy and structure (Keats & O'Neill (2001)).

This move from causal arguments about the relationship between strategy and structure to covariance is according to Keats & O'Neill (2001) an indicator of the complex nature of the relationship. Mintzberg (1994) explained the strategy–structure relationship by using the analogy of footsteps:

"...at one step the left foot leads the right, at the next step the right foot lead the left..."

It is not the purpose of this study to explore in detail the relationship between strategy and structure, suffice to note that these variables have a very strong impact on each other. In this section the focus will fall on the changing nature of organization design paradigms over the past hundred and twenty years, initially in response to changes within in the strategy landscape and later on as a catalyst for change within the strategy landscape.

2.3.1 Emergence of the Modern Organization (1900 – 1945)

Prior to World War I (WWI) the dominating principle for organizational design was based on the principles of Taylorism. FW Taylor (1856 – 1915) was the founder of Scientific Management (SM). SM sought to eradicate the industrial inefficiency and loss of leadership supposedly due to the growth in scale of enterprises and the managerial revolution. It sought a new legitimacy and discipline. The result was supposed to be a mental revolution in which worker–management conflict would be replaced by the scientific design of supervision and work organization. The theory introduced the idea of a functional foreman, and a thinking department to conduct research into task performance; detailed study and fragmentation of individual tasks in order to identify the "on best way" to be adopted by all workers. SM was the beginning of systematic work study in industry and impressed not only industrialist like Henry Ford but also leading figures in other environments (notably for example Lenin the future leader of the Soviet Union.)

It is generally accepted that Taylor's Scientific Management consisted of four principles:

- Replace rule-of-thumb work methods with methods based on a scientific study of the tasks;
- Scientifically select, train, and develop each employee rather than passively leaving them to train themselves;
- Provide detailed instruction and supervision of each worker in the performance of that worker's discrete task; and
- Divide work nearly equally between managers and workers, so that the managers apply SM principles to planning the work and the workers actually perform the tasks.

SM was however resisted at grass root level, by both workers and managers because it fundamentally ignored the nature of work as a social process, it had a dehumanized view of workers and treated work motivation in crude instrumental terms (see (Marshall (1994)) and (Braverman (1998)).

Despite the critique against the ideas propagated by Taylor the impact of his ideas are still seen within contemporary organizations.

According to business historian Chandler (1962) the Modern Organization emerged as a result of two important transformations:

- Line and Staff Structure;
- The Multi-Divisional Corporation.

2.3.1.1 Line and Staff Structure

Initially most companies were small and operated from a single plant or office. Limited communication and transport confined these companies to operate within its immediate vicinity. The invention of the railroad and the telegraph had a dramatic impact on this reality. It was suddenly possible to operate over a far wider geographical area. The implication of this was however the need for new organizational structure types and management systems.

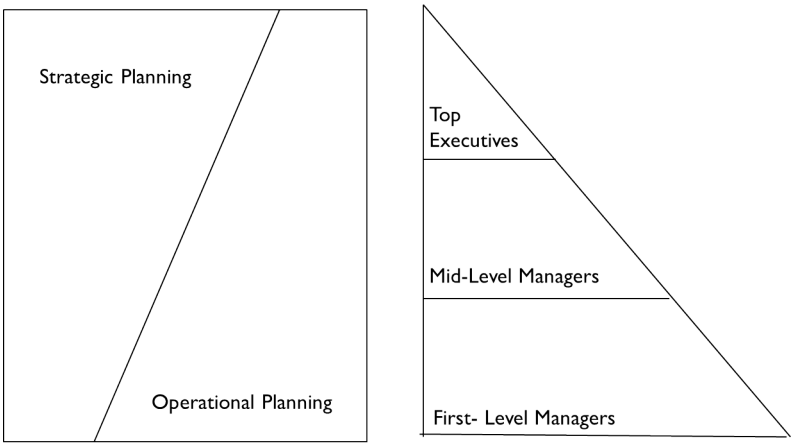
Weber promulgated the concept *Bureaucracy* in the early part of the previous century. In the formulation of his ideas regarding organizational structure Weber borrowed from the way in which roles and relationships were defined within the military and in his conception of the ideal Bureaucracy Weber made a clear distinction between line and staff functions. An organization formed on these principles would thus have clearly defined jobs, clear line of communication and authority (centralization and hierarchy) and clear division of labour (Keats & O'Neill (2001)).

The first companies to organize along these princles were the railroad companies in the US. Employees were either *line*, –allocated to operational tasks within a specific operational unit or *staff*, –typically located in some form of head-office structure and mainly responsible for administrative of specialists tasks (Grant (2010)).

2.3.1.2 The Multi-Divisional Corporation

The second important transformation that had a significant impact on the way in which organizations were designed and structured was the emergence of the Divisionalized Corporation during the 1920's. It was no longer possible to control these organizations through the traditional centralised and functional structures that characterized most organizations at the time. The pioneers were according to Grant (2010), DuPont and General Motors. The primary feature of the divisionalized corporation was the separation of operating and strategic responsibilities. General managers at divisional level were typically responsible for operations while strategic decision were taken at the head-office.

Figure 2.8: Planning levels in the bureaucratic organization



Adapted from Robbins & Coulter (2007).

2.3.2 Organizational Design changes – the emergence of the Bureaucratic Organization (1945 – 1990)

One of the key organizational and management characteristics of the period 1945 to 1990 was according to Weber (2009) the spread of a spirit of functional efficiency and measurement.

Løwendahl & Revang (1998) are of the opinion that this focus on rationalization has so dominated the thinking during this period that even though we saw the evolution of strategy models and paradigms the organizational archetypes have not really fundamentally changed or developed much in this time. When new organization forms were invented the process of rationalization forced it back to what these authors refer to as "the iron cage of Bureaucracy".

These organizational design principles were strongly influenced by the ideas of Weber and led to the development of clearly defined tasks, jobs and positions and clear formalized relationships between those who occupied them. The same principles characterized the relationship that existed between owners and employees. Employees typically had to sell their work capabilities in exchange for some form of remuneration.

Figure 2.8 illustrates the general role and responsibilities of different managerial levels within the bureaucratic organization.

2.3.3 Contemporary Organization design (1990 – current)

Business organizations exists because they are efficient institutions for the organization of economic activities. As illustrated above the main source of efficiency within an organization has traditionally been specialization which implied the division of labour into separate tasks. The consequence of task separation was however the need for better coordination and control. The main purpose of Organizational Design within this context was thus to reconcile specialization with cooperation and control. As a result, hierarchical structures have emphasized control and the need for unitary lines of command (Grant (2010)).

In Section 2.2.3 it is noted that the challenge faced by CO is no longer the definition of a grand plan, but rather the continuous generation of innovative and new ideas that would surprise and confound the competition and delight customers and potential customers. Within this context the building of outstanding and adaptive capabilities should be the primary function of organizational design. The focus is thus no longer on cooperation and control but rather coordination (Grant (2010)).

Drucker (1994) was one of the first contributors to juxtapose de-skilling, a typical result of the Taylorist/bureaucratic organizational archetype, with continuous learning, a typical requirement within the post-industrial and contemporary organization. Ghezzi (2013) points out that rather than rationalization, a contrary process came into play during the 1990's, where role occupants had to acquire more knowledge to be able to respond to fast changing circumstances. Each new discovery resulted in the expansion of knowledge and therefore greater options and more complexity.

Hage & Powers (1992) call this upward learning spiral "complexification". One consequences of complexification is an increased emphasis on Human Capital. In contrast to the clear definition of the "one best way" (the aim of scientific management) there is a growing trend towards the empowerment, emancipation and engagement of organizational members at all levels of authority and responsibility. There is thus a realization that all level of workers has the ability to both think and do (Clegg *et al.* (1999)).

There is a clear move away from clearly defined Job Description (JD)s. Knowledgeable workers are able to occupy multiple roles and their responsibilities and authorities shift, depending on the role they play at any given point. The result is the formation of temporary hierarchies. Although the empowerment of organizational members sound intuitively positive, the resultant complexification in terms of control and co-ordination introduces a number of other management challenges (Mumby & Putnam (1992)).

Table 2.2 summarize the major differences between the Mechanistic or Bureaucratic OD that characterized the period 1920 to 1990 and the Organic OD that is a growing reality within contemporary businesses.

Table 2.2: Mechanistic versus Organic Organizational Design

Feature	**Mechanistic**	**Organic**
Task Definition	Rigid and highly specialized	Flexible and less narrowly defined.
Co-ordination and control	Rules and directive vertically imposed	Mutual adjustment, common culture
Communication	Vertical	Vertical and horizontal
Knowledge sharing and learning	Centralized	Dispersed and blended
Commitment and Loyalty	To the immediate supervisor	To the organization and its goals
Environmental context	Stable with low technological uncertainty	Unstable with significant technological uncertainty and ambiguity

Adapted from Butler (1991)

Conditions within the CO is complex and uncertain and poses major theoretical and practical challenges for academics and practitioners alike. These challenges will be explored in more detail in Chapter 3.

Suffice to note that management dilemmas can no longer be solved by utilizing established methodologies and paradigms. Single minded focus as proposed by (Porter Porter (1980)), is no longer possible and management teams often has to focus on both innovation and efficiency simultaneously.

2.4 Strategy and the role of Strategy Control System and Management Control System

> *"The more we study the major problems of our time, the more we come to realize that they cannot be understood in isolation. They are systemic problems, which means they interconnected and interdependent."*
>
> Capra (1996)

Grant (2010) compares the relationship between organizational design (discussed in Section 2.3) and the Management Control Systems within the organization with the relationship that exists between computer hardware and software. Organization design provides the infrastructure, while management control systems provide the mechanisms of communication, decision making and control that allow organizations to solve the problems of coordination, cooperation and control (Grant (2010)).

Strategic and management control systems provide information that is intended to be useful to managers in performing their jobs and to assist organizations in developing and

maintaining viable patterns of behaviour. In order to understand management control systems and its potential impact on the successful execution of strategy it is important to have a general understanding of systems theory.

2.4.1 Systems thinking within the contemporary organization

Jackson (2010), defines a system as a complex whole, depending on the functioning and interaction of the parts. He identifies two major approaches to the evaluation and study of systems:

- Reductionism; and
- Holism[1].

The **Reductionist** approach to the study of systems firstly seek to identify and understand all the parts and then work up from an understanding of the parts to an understanding of the whole. The reality of this approach is however that the whole often has a form and function that is not recognizable from the parts. The whole then typically gives meaning to the parts – a living organism gives meaning to the heart, the lungs and liver.

Holism considers the system to be more than the sum of its parts. The holism approach to systems does take cognisance of the parts and more specifically the inter-relationships and the formation of networks between parts. Systems evaluation from a holistic perspective is however more concerned with the way in which the parts give rise to and sustain the new entity (the whole). The focus is thus on the whole and the functioning of the whole as opposed to the parts.

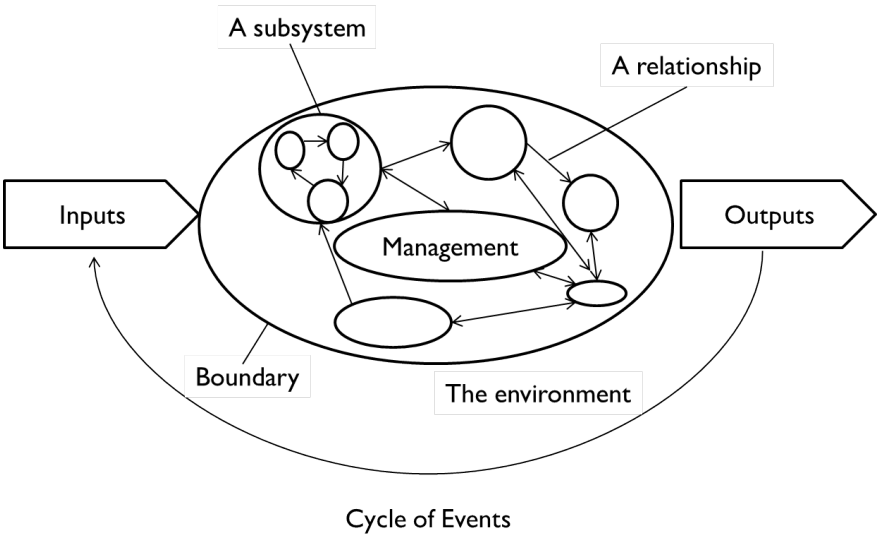
Holism gained according to Jackson (2010) a foothold in many different academic disciplines, assisting to overcome the problems associated with a reductionist approach when analysing system failure, especially when dealing with problems of a complex nature – such as the non-execution of strategy.

It is not the purpose of this section to provide a detailed analysis of systems thinking *per se*. A more detailed analysis can be found in Jackson (2000) and Checkland (1981). Suffice to state that the evaluation of systems in this section will be done by utilizing the principles of holistic system evaluation as described by Jackson (2010) as far as possible.

Von Bertalanffy (1968) evaluated systems in biology and concluded that the behaviour he witnessed in open biology systems could be demonstrated in open systems within other domains as well. This led to the formulation of what he named General Systems Theory (GST). GST was soon embraced by management thinkers who applied the model in their study of organizations (Jackson (2010)).

[1]The term holism is derived from Ancient Greek holos, meaning all, whole, entire and total (Jackson (2010))

Figure 2.9: The Biological System Model



Adapted from Jackson (2010).

The Biological System Model (BSM) presented by Von Bertalanffy (1968) and used in the development of the GST is represented in Figure 2.9.

In Section 2.4.1 this linear process was described by as a classical example of what Argyris (1977), Argyris (1991), Senge & Suzuki (1994) and Senge (2014) refers to as single-loop learning. In the discussion it was noted that Argyris (1977) already in 1977 between a distinction between single-loop learning and double-loop learning. This distinction had a significant impact on the way in which theorists and organizations conceptualize learning. It was illustrated that single-loop learning occurs when a mismatch is detected and corrected without changing the underlying values and status quo that governs the behaviours. Double-loop learning requires decision makers to question the underlying values and principles and requires the development of new routines and practices based on the new understanding of the universe. Argyris's ideas regarding double-loop learning have been applied by many theorists including Senge & Suzuki (1994) and Kaplan & Norton (1996b). Within the constraints of the Bureaucratic Organization (BO) the application of his ideas were however less effective. Double-loop learning have however become part of the design principles of many contemporary organizational processes, and is indeed embraced in the PAMSEEM. With single-loop learning the objectives are never questioned after they have been formulated, and all deviations from the planned trajectory is treated as failures.

Feedback and learning is however a continuous process and within the context of the Contemporary Organization the management team should continuously be vigilant in

the identification of signs that might indicate or require not only a change of plans but a fundamental rethink of the underlying objectives and principles.

According to Senge (2014) and Yang *et al.* (2004) learning organizations are skilled at the following activities:

1. Systems thinking;
2. Systematic problem identification;
3. Creation of a shared vision;
4. Creation and maintenance of a team learning environment;
5. Systematic problem solving and action planning; and
6. Regular reflection.

A detailed discussion of each one of these activities however falls outside the scope of this document. In the next section the focus will fall on the evolution of Strategy Control System (SCS)s and Management Control System (MCS)s *per se*. A number of control artefacts will be introduced during this discussion. This section will conclude with a more detailed evaluation of some of these artefacts and their impact on Strategy Execution (SE).

2.4.2 Control – An Organizational reality

> *"...all societies have norms and rules governing conduct, a society without some such norms is inconceivable. All equally have some mechanisms for ensuring conformity to those norms and for dealing with deviance. Social control is consequently a pervasive feature of society."*
>
> *Marshall (1994)*

The organizational and sociological issue is not the existence of social control, but determining its precise nature, and identifying the mechanisms at work in particular social contexts. Theorists and practitioners typically need to find answers to the following questions:

- By whom control is exercised?
- What techniques of control are used?
- How far can and do individuals resist processes of social control?

- In whose interest does control operate?

The answers to these questions vary greatly and largely depend on the vantage point from which the answer is formulated. It is not the main focus of this study to evaluate all possible answers to these questions, an understanding of strategic and management control systems and the possible implications of these systems has for the organization and more specifically the implications for effective Physical Asset Management (PAM) acrlongse is however essential.

As indicated above the conception of strategy and structure has evolved significantly over the past four decades. In response, patterns of Management Control (MC) in organizations has also evolved. It is however interesting to note that despite many calls for emperical research on the topic (Chenhall (2003); Dent (1991); Langfield-Smith (1997); Otley (1999)) there has been little explicit theorizing or empirical research on the topic. A detailed expose of recent contributions on the topic can be found in Ferreira & Otley (2009); Simons (1994); and Henri (2006). In the next section the evolution of Management Control System (MCS)s is briefly evaluated.

2.4.3 Control within the Modern Organization (1900 - 1945)

Classical economists such as Andrew Ure (1778 - 1857) and Charles Babbage (1791 - 1871) was according to Braverman (1998) the first to approach the problems of the organization and control of labour after the Industrial Revolution.

Between these men and the next step – the comprehensive formulation of management theory in the late 19^{th} and early 20^{th} centuries –, lies a gap of more than half a century during which there was an enormous growth in the size of enterprises, the beginnings of the monopolistic organization of industry, and the purposive and systematic application of science to production (Braverman (1998)).

The scientific management movement initiated in the last decades of the 19^{th} century was brought into being by these forces. As indicated above F.W. Taylor sought to eradicate the industrial inefficiency and loss of leadership due to the growth in scale of enterprises at the turn of the 19^{th} century. Taylor's ideas are discussed in detail in Section 2.3.1. For the purpose of the contextualization of Management Control within the MO it is important to again highlight Taylor's conception of workers and managers. His assumption was that unlike management, workers are of limited intelligence, innately idle and driven by the need for immediate gratification. For this reason Taylor was of the opinion that scientific means should be utilized to determine "a fair day's work for a fair day's pay". In this way individual economic reward would be linked directly to task completion, as the only means of compelling workers to work.

It is according to Braverman (1998), impossible to overestimate the importance of the Scientific Management movement in the shaping of the MO and indeed all institutions of capitalist society which carry on labour processes.

It is however not only Braverman who regards the impact of Taylors work very highly. According to Drucker (1954) the concept SM underlie all management discourse within the MO.

> *"Indeed, scientific management is all but a systematic philosophy of worker and work. Altogether it may well be the most powerful as well as the most lasting contribution America has made to Western thought since the Federalist Papers*[1] *."*

As indicated Taylor's ideas was however resisted at grass roots level, by both workers and managers because it fundamentally ignored the nature of work as a social process, it dehumanized workers and treated work motivation in crude instrumental terms. In line with changes in the strategy and organizational landscape ideas regarding Management Control also evolved after WWII.

The seminal work by Anthony (1965) made a major contribution to the theory and practice of Management Control within the Bureaucratic Organization (BO). In the next section MC within the BO will be evaluated in more detail.

2.4.4 Control within the Bureaucratic Organization

Anthony (1965) presented a framework for strategic analysis and planning. In his framework he made a distinction between Strategic Planning, Management Control and Operational Control. He defined *Strategic Planning* as the process during which decision makers decide on changes in the organizational objectives, the allocation of resources and the policies that need to be developed to ensure the acquisition and use of these resources.

He defined *Management Control* as the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organizations objectives.

Operational Control is described as the process of deploying resources to ensure optimum levels of productivity.

Management Control is thus a linking process between Strategic Planning and Operational Control. Otley (1999) is of the contention that Anthony's approach was intended to achieve two aims:

[1]The Federalist Papers are a series of 85 articles and essays written by Alexander Hamilton, James Madison, and John Jay promoting the ratification of the United States Constitution. There were many different ideas, of which 'federalism' was only one. Many people didn't trust a strong central government that would have certain rights over states. The Federalist Papers popularized the idea of federalism. They explained why it was important for us to have a strong central government rather than just be a league of states, each state being sovereign, like the European Union today. Without that idea being popularized and accepted, the USA governmental system might look very different today (Jackson *et al.* (2010))

- To broaden the scope of information that was traditionally considered when decisions were made, beyond just accounting information; and
- To ensure that issues of managerial motivation and behaviour are considered during the control process.

Otley (1999) is of the opinion that Anthony was largely unable to broaden the scope of information used during the decision making process. Financial information was relatively easy to acquire and the accounting language was (and to a large extent still is) the only business language that is universally understood. Focusing on commonalties required the use of a common language capable of including all organizational activities. Accounting provided such a language and *MC* (as defined by Anthony (1965) became largely synonymous with Management Accounting.

It was far more difficult to develop generic *Operational Control Systems* and frameworks because different organizations used very different practices at the operating level. For many decades the development of *Operational Control Systems* did not receive the same amount of theoretical attention and thus did not develop at the same rate as *MCSs*. The Strategy Execution problems experienced by contemporary organization might well have its roots in this lack of theoretical focus on the development of universally accepted and understood *Operational Control* mechanisms.

Anthony was according to Otley (1999) more successful in achieving his second goal. His work did make a major contribution in changing the views propagated by the Scientific Management movement regarding the ability of workers to add value beyond mere compliance.

Control within the Bureaucratic Organization was thus focused on:

- Providing information, more specifically accounting information to keep things on track;
- Individual responses to that information; and
- The formulation of defensive strategies designed to cope with the situations when things were seemingly not on track any longer.

The limitations of this approach to control within the contemporary business landscape is clear and is mainly concerned with the nature of strategy, goals and objectives as well as Organizational Design within the Contemporary Organization. Ruefli & Sarrazin (1981) is of the contention that the emphasis of bureaucratic models of Management Control, is on the analysis of the difference between short term objectives or forecasts and actual output. Long term (read strategic) decisions are considered as given and irreversible, or taken into account only through their short term effects. Control, in this sense, is usually presented as the third step in the sequence: planning–operations–control.

Within the Contemporary Organization strategy formulation is generative and dynamic and some instance co-incidental (see the discussion in Section 2.2.3). Within this context financial reports (the basis on which Bureaucratic Management Control is build) might still be a true indication of historic goal achievement, but they only provide a "rear mirror" view of operational performance, and does not have predictive value. Within the Contemporary Organizational context the control system should have predictive capabilities Otley (1999).

Despite the fact that Anthony (1965) did attempt to broaden the scope of the control process critics are furthermore concerned that the bureaucratic approach to control was still too restrictive and less concerned with the behavioural aspects of the organizational participants Berry *et al.* (1995). In the next section the contemporary manifestations of Management Control will be evaluated.

2.4.5 Contemporary manifestations of Organizational Control

It is according to Langfield-Smith (1997) surprising to note that strategy was not used explicitly as a variable in Management Control System (MCS) research until the 1980s. In recent years there has been a growing interest in the relationship between MCSs and strategy. (See Dent (1991); Simons (1994); Otley (1999); Ferreira & Otley (2009) and Henri (2006)). Much of the empirical research in this area follows according to Langfield-Smith (1997) a contingency approach and involves a search for systematic relationships between specific elements of the MCS and the particular strategy of the organization.

Ferreira & Otley (2009) seem to agree with Langfield-Smith and note that there has been a tendency to focus only on specific aspects of control systems, as opposed to adopting a more comprehensive and integrated approach. Ferreira & Otley (2009) is however critical of this approach and notes that our understanding of MCS will remain "piecemeal" for as long empirical research continues to ignore the interdependency between different control mechanisms operating at the same time in the same organization.

While prior studies have thus highlighted the importance of achieving a fit between an organization's MCS and its strategy, the interrelationship between MCS and strategy is not all that clear. Kober *et al.* (2007) is of the opinion that even in those instances where the relationship between MCS and strategy has been explored it has traditionally been viewed as one in which the MCS was seen as an outcome of organizational strategy. In the same way theorists for very long accepted that "structure follows strategy" (see discussion in Section 2.3.1.

A number of theorists (van Veen-Dirks & Wijn (2002); Kober *et al.* (2007) Ferreira & Otley (2009)) elude to the fact that a more complex two-way association is however most probably more accurate. The essence of MCSs is according to Simons (1991) to manage the inherent organizational tension between creative innovation and predictable goal achievement. Kober *et al.* (2007) refer to three kinds of inherent tension that need to be reconciled and balanced to allow the effective control of business strategy:

- Unlimited opportunity versus limited attention;
- Intended versus emergent strategy; and
- Self-interest and desire to contribute.

Managers use MCSs as positive and negative forces to create dynamic tension that contributes to manage inherent organizational tension.

The Levers of Control framework: Simons (1994) proposed the Levers of Control (LOC) framework as a tool for the implementation and control of business strategies. He identifies four organizational control systems which he refers to as the LOC:

The LOC framework is briefly summarised in Table 2.3.

Table 2.3: Simon's Levers of Control framework

Lever of Control	**Description**
Beliefs system	Guides the creative process of exploring new opportunities and instils widely shared beliefs
Boundary system	Plays the negative, limiting role of circumscribing the domain where the company seeks new opportunities
Diagnostic control system	Monitor, assess and reward achievement on key areas of performance
Interactive control system	Encourage organizational learning and the process of development of new ideas and strategies

Adapted from Simons (1991)

Each one of these levers are discussed in more detail in the following paragraphs.

Belief system: According to Simons (1994) the beliefs system is the explicit set of organizational definitions that senior managers communicate formally and reinforce systematically to provide basic values, purpose, and direction for the organization. A belief system thus communicates core values in order to inspire and motivate employees to search, explore, create, and expend effort engaging in appropriate actions. In a dynamic environment there must however be some restraint placed on employees to stop them from engaging in high-risk behaviors. This restraint is the "boundary system", which acts in opposition to the beliefs system.

Boundary system: A boundary system delineates the acceptable domain of strategic activity for organizational participants. The boundary system communicates the actions that employees should avoid. Its purpose is to allow employees freedom to innovate and achieve within certain pre-defined areas. The boundary and beliefs systems are similar in

that they both are intended to motivate employees to search for new opportunities. The boundary system does so in a negative way through the constraint of behavior while the beliefs system does so in a positive way through inspiration. Often, firms communicate beliefs through a mission or vision statement and boundaries through a code of conduct (Widener (2007)).

Diagnostic Management Control System (DMCS): DMCSs are the formal information systems that managers use to monitor the organizational outcomes and to correct deviations from pre-set standards of performance. Most of the control systems developed within the bureaucratic organization was typically diagnostic in nature.

The main characteristics of DMCSs are according to Simons (1991):

1. They facilitate measurement of the outputs of a process;
2. They provide predetermined standards against which actual results can be compared; and
3. They can correct deviations from standards.

DMCSs measure corporate performance by measuring actual achievements and by comparing them with pre-set standards and other desirable results. The organization can therefore adjust its activities according to the targets set during the planning stage. Management can also set allowance levels for possible fluctuations. Between those levels, direct intervention is not necessary.

DMCSs however typically constrain innovation and opportunity–seeking to ensure predictable goal achievement needed for intended strategies. It encourage conservatism and a "playing it safe" or "don't fix it if it ain't not broken" attitudes (Simons (1991)).

Interactive Management Control System (IMCS): IMCSs focuses on adapting the strategy to the changing environment, providing a framework for a more incremental and emergent approach to strategy formulation. The main characteristics of IMCSs are according to Simons (1991):

1. These systems start with a subset of management control information, which is considered important, given the strategic uncertainties faced by an organization;
2. Information generated by the system is an important and recurring agenda addressed by the highest level of management;
3. Such a system demands frequent and regular attention from operating managers at all levels;
4. Data generated by the system are interpreted in face-to-face meetings of superiors, subordinates, and peersand are discussed in light of future strategic initiatives;

5. These strategy meetings take the form of debate of the underlying data, assumptions, and action plans.

Kober *et al.* (2007) note that in the management of inherent organizational tension between creative innovation and predictable goal achievement, IMCS supports the development of ideas and creativity.

> *"Senior managers use interactive control systems to build internal pressure to break out of narrow search routines, stimulate opportunity–seeking, and encourage the emergence of new strategic initiatives*

IMCSs however requires the active involvement of managers at all levels. If only the time spend by senior managers during the control process is thus quantified the deployment of an IMCS in all parts of the business can become very costly.

Table 2.4 provides a comparison between the main characteristics of DMCS and IMCS.

Table 2.4: Comparison between DMCS and IMCS

	Diagnostic Control	**Interactive Control**
Purpose	Provide motivation and direction to achieve goals	Stimulate dialogue organizational learning
Goal	No surprises	Creative search
Analytical complexity	Deductive	Inductive
System complexity	Complex	Simple
Time frame	Past and present	Present and future
Targets	Fixed	Constantly re-estimated and set by business environment
Feedback	Negative	Positive
Adjustment to	Inputs or process	Double loop learning
Communication	Eliminate need for talk and provide necessary information	Provide common language
Staff role	Key gatekeepers translate customer needs into products and services	Facilitators

Adapted from van Veen-Dirks & Wijn (2002)

Both types of controls are according Kober *et al.* (2007) necessary within an organization as they are used for different purposes. DMCSs serve to measure and monitor outputs, and correct deviations from preset measures of performance. Although DMCSs assisted organizations to pursue intended strategies, such systems did not encourage organizations to consider new opportunities. Interactive Controls, on the other hand, focus attention on strategic uncertainties. These systems encouraged continual dialogue and debate, thus creating competitive pressure within the organization to innovate and adapt. Consequently, new strategies could emerge.

In conclusion some of the major strengths and weakness of the LOC framework are presented in Table 2.5.

Table 2.5: Strengths and Weaknesses of the LOC framework

Strenghts	**Weaknesses**
• Strong strategic focus (Ferreira & Otley (2009));	• Not enough emphasis on socio-ideological controls (Collier (2005))
• Cover a broad perspective of control systems used in the organization;	• Too strong focus on the role of top management Ferreira & Otley (2009);
• Association of control mechanism with Levers of Control enables better understanding of MCS design (Widener (2007)); and	• Does not really deal with the range of informal control mechanisms usually at play in organizations (especially smaller ones) (Ferreira & Otley (2009));
• The framework provides a useful typology to assess the extent to which there is a balance between the positive and negative aspects of control (Bisbe *et al.* (2007) and Simons (1994)) and (Ferreira & Otley (2009)).	• The meaning of concepts used in the model e.g. "core value", and "belief system" are diffuse and leave scope for interpretation (Collier (2005));
	• Does not adequately explain operational control (Otley (1999)); and
	• The framework is not universally applicable and in unable to explain the unique control dynamics for example subsidiaries. In subsidiaries the belief and boundary system is typically determined by the holding company and this beyond the control of the subsidiary (Ferreira & Otley (2009)) and (Otley (1999)).

In the light of the critique against the LOC framwork and considering the widespread acceptance of the need to adopt a more comprehensive approach to the study of MCS (Chenhall (2003); van Veen-Dirks & Wijn (2002); Kober *et al.* (2007); and Ferreira & Otley (2009)) that takes research beyond specific aspects of control systems and the limitations of existing frameworks, Ferreira & Otley (2009) developed the following extended MCS framework. In the next section the Performance Management System Framework (PMSF) is evaluated in more detail.

The Performance Management System Framework: – The PMSF is according to Ferreira & Otley (2009) intended to provide a broad view of the key aspects of MCSs and to form the basis upon which further investigations can be developed. The naming of

the framework aims according to the authors to reflect a shift from the bureaucratic and often compartmentalized approaches to control in within the Bureaucratic Organization (see discussion in Section 2.4.4) to a broader perspective of the role of control in the managing organizational performance. The PMSF consists of ten "what" and two "how" questions. The 12–question PMSF is outlined below:

1. What is the vision and mission of the organization and how is this brought to the attention of managers and employees? What mechanisms, processes, and networks are used to convey the organization's over-arching purposes and objectives to its members?

2. What are the key factors that are believed to be central to the organization's overall future success and how are they brought to the attention of managers and employees?

3. What is the organization structure and what impact does it have on the design and use of Performance Management System (PMS)s ? How does it influence and how is it influenced by the strategic management process?

4. What strategies and plans has the organization adopted and what are the processes and activities that it has decided will be required for it to ensure its success? How are strategies and plans adapted, generated and communicated to managers and employees?

5. What are the organization‘s key performance measures deriving from its objectives, key success factors, and strategies and plans? How are these specified and communicated and what role do they play in performance evaluation? Are there significant omissions?

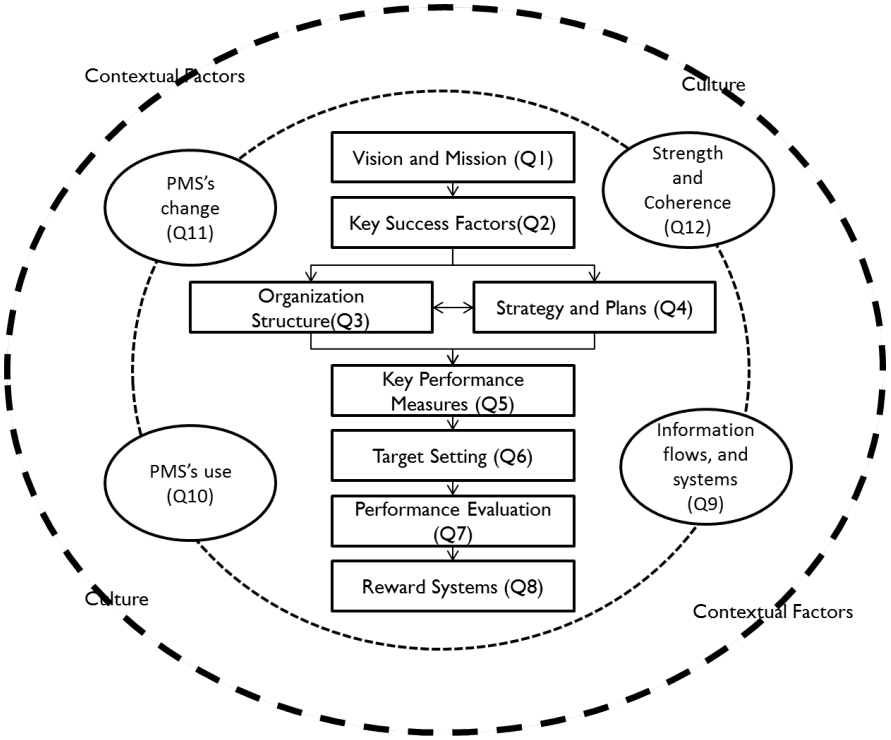
6. What level of performance does the organization need to achieve for each of its key performance measures (identified in the above question), how does it go about setting appropriate performance targets for them, and how challenging are those performance targets?

7. What processes, if any, does the organization follow for evaluating individual, group, and organizational performance? Are performance evaluations primarily objective, subjective or mixed and how important are formal and informal information and controls in these processes?

8. What rewards – financial and/or non-financial – will managers and other employees gain by achieving performance targets or other assessed aspects of performance (or, conversely, what penalties will they suffer by failing to achieve them)?

9. What specific information flows feedback and feed-forward , systems and networks has the organization in place to support the operation of its PMSs?

Figure 2.10: The Performance Management Systems Framework



Adapted from Ferreira & Otley (2009).

10. What type of use is made of information and of the various control mechanisms in place? Can these uses be characterized in terms of various typologies in the literature? How do controls and their uses differ at different hierarchical levels?

11. How have the PMSs altered in the light of the change dynamics of the organization and its environment? Have the changes in PMSs design or use been made in a proactive or reactive manner?

12. How strong and coherent are the links between the components of PMSs and the ways in which they are used (as denoted by the above 11 questions)?

The framework is presented schematically in Figure 2.10. As can be seen there are two aspects that forms a critical part of the PMSF that are not explicitly addressed by the above questions. These are "contextual factors" and "organizational culture".

Contextual factors typically include:

- The external environment;

- Organizational strategy;
- Ownership structure;
- Organizational structure;
- Technology used; and
- Organizational size.

Organizational culture permeates the entire control system and influence behaviours and choices of individuals (Hofstede *et al.* (1997)). The study of the operation of the PMSs would require the consideration of these factors even if only implicitly. It is important to note that strategy and organizational structure are two of these factors that are already explicitly built into the framework because they are significantly influenced by the organization itself. The evolution of these two factors were also evaluated in detail in this chapter. The other factors can be seen primarily as external influence and thus more contingent variables that might explain why certain patterns of control are more or less effective, rather than characteristics of the control system that need to be incorporated into a description (Ferreira & Otley (2009)).

Conclusion The LOC framework as well as PMSF frameworks might not be completely exhaustive but they are coherent frameworks and have an underlying logic that will assist in the development of a model for the early detection and prevention of PAM Strategy Execution in Chapter 6. In the next section MCS artefacts used within contemporary organizations will be briefly evaluated.

2.4.6 Management Control System artefacts

Berry *et al.* (2009) points out that Management Control (MC) is socially enacted with both technical and social artefacts. Organizations rarely make their own artefacts, but they do modify the ones they have inherited or had installed. He also notes that the development of control artefacts is normally not done by academics with a interest in the MCS field, but rather by the community of management consultants.

Berry *et al.* (2009) further notes that these artefacts are embodiments of both practice, theory and culture. They typically reflect the struggles to create them and the modifications through the experience of using them.

The past five decades has seen the development of a number of MCS artefacts. In this section the following permutation of artefacts will be briefly introduced and evaluated. In Section (4.4.3.3) the application of these artefacts are contextualized within the context of PAM.

- Decision Support System (DSS);

- Economic Value Add (EVA);
- Activity Based Costing (ABC);
- Balanced Scorecard (BSC); and
- Six Sigma ($6-\sigma$)

In the next section the focus will fall on Decision Support System. DSS is often used as an umbrella term to describe all computerized systems used to support decision making and ultimately management control in an organization.

2.4.6.1 Decision Support System

In the early 1970's Gorry & Morton (1971) first described major DSS concepts. They defined DSS as:

> ... *"interactive computer–based systems, which help decision makers utilize data and models to solve unstructured problems."*

Keen & Morton (1978) provided the following classic definition of DSS:

> *"Decision Support Systems couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions. It is a computer based support system for management decision makers who deal with semi-structured problems."*

An organization might have an executive information system for its top executives, separate DSS for marketing, finance and accounting, human resource management and several expert systems for product repair diagnostics and help desks.

The effective management of information is an essential prerequisite for effective decision making and management control. The amount of data that must be monitored and analyzed by corporate decision makers requires specialized aids and skills.

During the past decade, capabilities for data analysis and data mining have developed exponentially as computing power has followed Moores law[1] of doubling every 18 months.

[1]Moore's law is the observation by Moore *et al.* (1965) that, over the history of computing hardware, the number of transistors on integrated circuits doubles approximately every 18 months. The law is named after Gordon E. Moore, co-founder of Intel Corporation, who described the trend in his 1965. According to Disco & Van der Meulen (1998) his prediction has proven to be accurate, in part because the law is now used in the semiconductor industry to guide long-term planning and to set targets for research and development. This exponential improvement has dramatically enhanced the impact of digital electronics in nearly every segment of the world economy. Moore's law describes a driving force of technological and social change in the late 20^{th} and early 21^{st} centuries. The number of transistors on integrated circuits might not double at exactly the pase Moore predicted. Within the technology world Moore's law is however synonymous with very fast changes

However, until recently, the task of conducting powerful data analysis has been relegated to well-trained analysts and experts within respective fields. Decision makers were thus according to Malik (2005) depended on this group of "information champions" to disperse information.

If decision makers required information that was not pre-defined an ad hoc report had to be submitted. The development of these ad hoc reports often took so long that by the time the requesting manager/decision maker received the information the information was often obsolete, or perhaps the need for that specific information had evaporated because of rapidly changing daily priorities. The information seeker was thus often forced to base decisions on intuition (Malik (2005)).

Over the last number of decades a number of DSS aids and methodologies have emerged. Table 2.6 summarizes the evolution of DSS aids over the past four decades.

Table 2.6: The evolution of aids in decision making

Phase	**Description**	**Examples of tools**
Early	Compute crunch numbers, summarize, organize	Calculators, early computer programmes, statistical models, simple management science models
Intermediate	Find, organize and display decision relevant information	Database management systems, MIS, filing systems, management science models
Current	• Perform decision relevant computations on decision relevant information; organize and display results; query based and user friendly approach; what if analysis; • Interact with decision makers to facilitate formulation and execution of the intellectual steps in the process of decision making	• Financial models, spreadsheets, trend exploration, operations research models, CAD systems, decision support systems; and • Expert systems, executive information systems.
Future	Complex and fuzzy decision situations, expanding to collaborative decision making and machine learning	Second generation expert systems, group DSS, neural computing

Adapted from Turban et al. (2007)

The perceived benefits for the use of DSS included higher decision quality, improved communication, cost reduction, increased productivity, time savings, and improved customer and employee satisfaction. Factors such as the degree of competition, the industry,

the size of the company, and user friendliness of the DSS were found to be highly correlated with the perceived benefits of the DSS (Turban *et al.* (2007)).

It is important to note that although the need for DSS is paramount within the complex contemporary organization, DSS is not a contemporary development.

As indicated in Section 2.4.2, Anthony (1965) drew boundaries between Management Control, Strategic Planning and Operational Control. He is of the opinion that Management Control is contrasted with the ideas of:

- Strategic Planning: concerned with setting goals and objectives for the whole organization over the long term; and
- Operational Control: concerned with ensuring that immediate tasks are carried out.

Simon (1977) defined both the decision making process and the different types of managerial decisions. According to him the decision making process consists of three phases:

1. Intelligence: searching for conditions that call for decisions;
2. Design: inventing, developing and analyzing possible courses of action; and
3. Choice: selecting a course of action from those available.

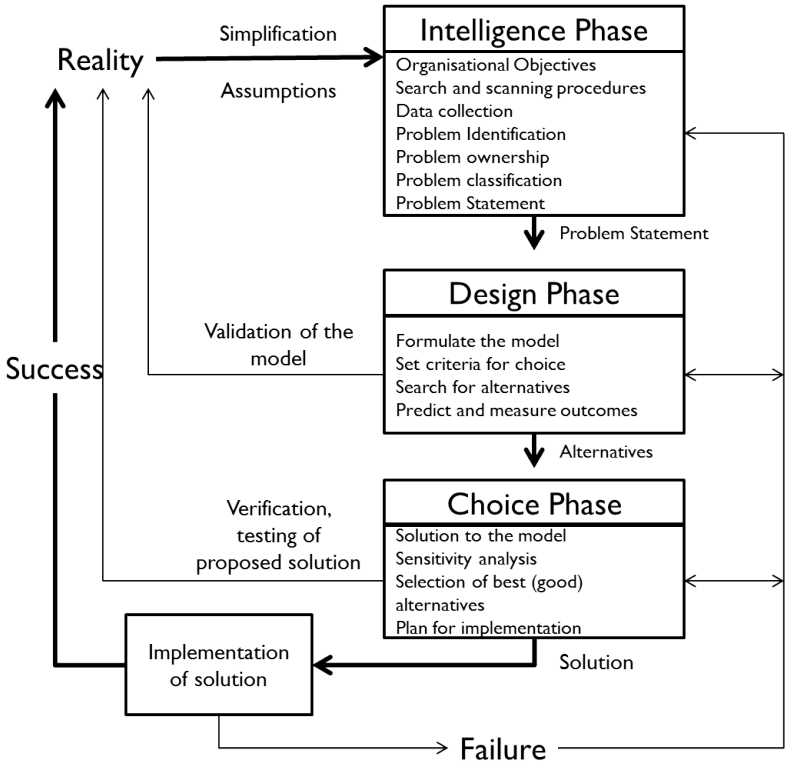
A fourth phase, *"implementation"*, was added later. A conceptual model of the decision making process as conceptualized by Simon is shown in Figure 2.11.

As indicated Simon (1977) also identified three types of managerial decisions:

- Structured;
- Semi-structured; and
- Un-structured.

Gorry & Morton (1971) combined the work of Anthony (1965) and Simon (1977) and developed a basic decision making framework. The framework is presented in Table 2.7. In the framework the authors used Simon's three types of decision on the vertical axis and Anthony's three types of management control on the horizontal axis.

Figure 2.11: The decision making/modelling process



Adapted from Turban et al. *(2007)*

Table 2.7: Framework for decision making

Type of decision	Operational Control	Managerial Control	Strategic Planning
Structured	Accounts receivable, order entry	Budgtet analysis, short term forcasting, personnel reports, make or buy	Financial management (investment), warehouse location, distribution systems
Semi-structured	Production scheduling, inventory control	Credit evaluation, budget preparation, plant layout, project scheduling, reward system design	Building new plant, mergers and acquisitions, new product planning, compensation planning, quality assurance planning
Un-structured	Selecting a cover for a magazine, buying software, approving loans	Negotiating, recruiting an executive, buying hardware, lobbying	R&D planning, new technology development, social responsibility planning

Adapted from Turban et al. (2007)

Cooke & Slack (1991) categorized decisions along three dimensions:

- Strategic–Operational;
- Unstructured–Structured; and
- Dependent–Independent.

Strategic–Operational dimension: – These authors describe strategic decisions as those which are concerned with the relationship of the organization to its environment, and affect or involve all or a large part of the organization. These decision are often unique and have little or no precedents. Within the typical Bureaucratic Organization strategic decisions were usually taken by senior managers. This is however not the case within the Contemporary Organization (CO) (as illustrated above). Within the CO these decisions are strongly influenced by lower levels of management. Operational decisions are largely confined to one part of the organization and the focus is normally internal relating to matters concerned with the transformation of inputs into outputs. They are often routine and so procedures for making them may have been established, that is to say they are programmable. They are usually taken in the lower ranks of the hierarchy.

Structured–Unstructured dimension: A structured decision is clear, well-defined, distinct and unambiguous. There are established and agreed procedures for making it. It is quite clear who the decision maker should be, and the possible outcomes are predictable. Un-structured decisions are ill-defined and fuzzy. There are no known rules or procedures for making it. It may not be clear who should make the decision, or even whether there is a decision to make. The outcomes are unpredictable.

Dependent–Independent dimension: A dependent decision is one which cannot be taken independently of decisions made in other, perhaps all, parts of the organization. It may also be dependent on decisions taken in the past, which have pre-empted some of the options, and it may in turn predetermine future decisions. An independent decision can be taken without taking into account decisions made elsewhere in the organization. It has no time-based consequences or preconditions of the kind mentioned above.

Often, these dimensions are used in combination. Thus, strategic decisions normally are unstructured and dependent whereas operational decisions usually are structured and independent.

It is not the purpose of this section to provide a comprehensive analysis of decision making frameworks. More comprehensive analysis can be found in Turban *et al.* (2007). Suffice to state that a distinction can be made between various types of decisions and that these decision are made and influenced by various role-players within the organization. When evaluating decision making effectiveness within a specific organization it would be essential to map the types of decisions taken as well as the roles and responsibilities of various organizational stakeholders *vis a vis* these decision types.

In this section the focus fell on the challenges managers face regarding decision making. Theorist and practitioners are constantly seeking ways to strengthen their operations and gather more accurate data for decision making. Activity Based Costing had its origins in the work done by George Staubus (Staubus (1971)), but was first clearly defined in 1987 by Bruns & Kaplan (1987)[1]. ABC aims to help managers to identify the costs involved in the manufacturing or maintenance of a product or service more accurately. In the next section ABC as a MCS artefact will be evaluated in more detail.

2.4.6.2 Activity Based Costing

During the 1990's ABC was considered by many academics and practitioners as one of the most important innovations in management accounting and control in the 20^{th} century along with variance analysis, Return on Investment (ROI), Economic Value Add (EVA) and the Balanced Scorecard (BSC) (Gosselin (1997)). The concept of ABC is subject to varying interpretation and its definition has evolved over time.

According to Brewer *et al.* (2008) ABC is a two-stage procedure used to assign overhead costs to products and services produced. In the first stage, significant activities are identified, and overhead costs are assigned to activity cost pools in accordance with the way the resources are consumed by the activities. In the second stage, the overhead costs are allocated from each activity cost pool to each product line in proportion to the amount of the cost driver consumed by the product line.

Brewer *et al.* (2008) indentifies a number of benefits and limitation of ABC as a management control and decision making instrument. These benefits and limitation are

[1]Kaplan is also one of the main proponents of the Balanced Scorecard (See discussion in Section 2.4.6.4).

summarized in Table 2.8

Table 2.8: Activity Based Costing – Benefits and Limitations

ABC Benefit	**ABC Limitations**
• ABC increases the number of cost pools used to accumulate overhead costs; • ABC changes the base used to assign overhead costs to products and services. Rather than assigning costs on a basis of for example direct labour cost, cost are assigned on a proportional basis; • ABC changes a managers perception of many overhead costs in that costs that were formally though to be indirect (such as power and machine set-up) are traceable to specific products and services; • ABC empowers managers to make more informed decisions regarding real production cost that should impact decisions regarding product retention, marketing strategy and product profitability.	• Although some overhead costs can be traced directly to products of services, some cost (especially at the facility level) still need to be allocated arbitrarily. It is thus argued that in those instances where facility-level cost typically account for the bulk of overhead cost, the use of ABC becomes largely meaningless; and • The most important limitation of ABC is however the cost and complexity involved with its implementation. Even a moderately complex system requires a great amount of detail and many computations in order to determine the cost of a unit of a product.

Adapted from Brewer et al. (2008)

Although ABC is very attractive from a conceptual point of view, survey studies (see Abrahamson (1996) and Gosselin (1997)) has shown that many organization has abandoned the implementation of ABC systems. Even in those instances where in the 1990's organizations did include ABC principles in their managerial accounting practice they currently rely on less complex costing tools.

A more detailed evaluation of ABC falls outside the scope of this study. An important lesson should however be learned when evaluating the rise and fall of ABC as a management control tool. Irrespective of the inherent value of the tool or potential contribution it can make to improved decision making, such a tool will only gain and sustain traction if it is cost effective to implement and practical to use on a continuous basis.

In the next section the principles of Economic Value Add (EVA) as a MCS artefact will be evaluated in more detail.

2.4.6.3 Economic Value Add (EVA)

Organizations formulate strategies, design structures and implements control systems to ensure sustainability and to add shareholder value. Economic Value Add (EVA)[1] is a performance metric that calculates the creation of shareholder value, but is far more involved and according to Stern *et al.* (1995) far more accurate than traditional financial performance metrics such as Net Profit and Earning per Share (EPS). EVA is the calculation of what profits remain after the costs of a companies capital – both debt and equity – are deducted from Operating Profit. EVA has been developed by Stewart Bennett (Stewart III (1991)) as an overall measure of financial performance that is intended to focus the minds of managers on the delivery of shareholder value. EVA is promoted as being preferable to other relatively inexpensive measures such as EPS and ROI in aligning shareholder and manager goals.

There are four steps in the calculation of EVA:

1. Calculate Net Operating Profit After Tax (NOPAT);
2. Calculate Total Invested Capital (TIC);
3. Determine the Weighted Average Cost of Capital (WACC); and
4. Calculate EVA = (NOPAT − WACC%) × TIC

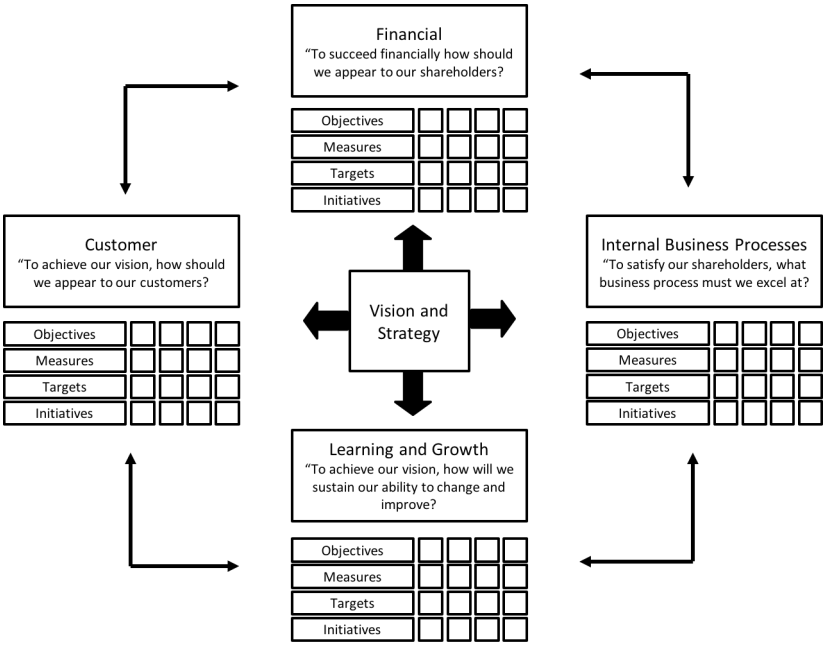
The steps appear straightforward and simple, but the calculation of EVA is often complex and according to Stern *et al.* (1995) requires literally dozens of adjustments to earnings and balance sheets – in areas like Research and Development, inventory, costing, depreciation and amortization of goodwill. The calculation of the WACC can also be extremely difficult and is a function of the capital structure (proportion of debt and equity on the balance sheet), the stock's volatility measured by its beta, and the market risk premium. Small changes in these inputs can result in big changes in the final WACC calculation.

Analysts are however of the opinion that if the EVAformula is applied consistently, EVA should help to identify the best investments, that is, the companies that generate more wealth than their rivals. Firms with high EVAs should over time outperform others with lower or negative EVAs.

Although EVA has already been introduced by Stewart III (1991) in 1991 the metrics only became popular toward the late 1990's. Currently many large multi–national corporations such as Coca-Cola, GE and AT&T, use EVA internally to measure wealth creation performance. Investors and analysts are also increasingly scrutinizing company EVA in the same way they used to observe EPS and Price Earnings (P/E) ratios. EVA is thus not only a reflection of past performance but more importantly has predictive capability.

[1]EVA is a trademark of the Stern Stewart Corporation.

Figure 2.12: The Balanced Scorecard Framework



Reproduced from Kaplan & Norton (1996b).

A detailed analysis of EVA falls outside the scope of this discussion. The predictive capabilities of EVA however makes the metrics extremely attractive. The main aim of this study is to develop a model for the early detection and prevention of PAM Strategy Execution Failure. The principles applied in the development and use of EVA are considered in the development of the model discussed in Chapter 6.

2.4.6.4 The Balanced Scorecard

The Balanced Scorecard (BSC) is a strategy management control tool developed by David Norton and Robert Kaplan and described in an article published in the Harvard Business Review (Kaplan & Norton (1996b) and later in far more detail in their book *"The Balanced Scorecard"* (Kaplan & Norton (1996a)).

The BSC aims according to Nørreklit (2003) to address the shortcomings and management problems caused by the fact that most accounting systems are backward focused and thus only provide a historical view of company performance. The inherent shortcomings of traditional management accounting systems has over the years been well documented (see Dearden (1969), Vancil & Buddrus (1979), Dearden (1987), Simons (1987), Simons (1994), Johnson & Kaplan (1987)).

The BSC aims to translate the organizational mission and strategy into objectives and measure organized into four different perspectives:

- Learning and Growth;
- Internal Business Process;
- Customer; and
- Finance.

According to Banker *et al.* (2011) the BSC typically contain between 16 and 28 different measures grouped into the four perspectives. According to Kaplan & Norton (1996a), each Strategic Business Unit (SBU) within a firm should have its own scorecard reflecting its distinct strategy, and the its alignment to the organizational strategy at large.

Figure 2.12 illustrates the BSC framework.

The BSC provides according to Kaplan & Norton (1996a):

> *"...a framework and a language to communicate the mission and strategy, and it uses measurement to inform employees about the drivers of current and future success..."*

The assumption made by Kaplan and Norton is that there is a cause-and-effect relationship between the suggested perspectives and that good performance in for example Learning and Growth variables will lead to good performance in Internal Business Processes variables and so on.

The past two decades has seen high adoption rates of BSC principles within a wide range of sectors. Although the BSC concept has been adopted by industry as a base for strategic management systems, many researchers, including (Neely *et al.* (2002); Otley (1999); Ferreira & Otley (2009); Alsyouf (2006); Kumar *et al.* (2013); Garg & Deshmukh (2006a); Marr *et al.* (2004); Banker *et al.* (2011); Atkinson (2006)) have been critical about its general application.

The following list highlights some of the critique these contributors have:

- The BSC is according to Banker *et al.* (2011) inherently complex. The framework requires decision makers to evaluate multiple performance measures (at least 1628 as indicated above) for two or more SBUs and they need to understand relationships between performance measures and their relevance to the overall strategy;

- It does not illustrate the cause and effect relationships between variables clearly enough, Strategy Maps[1] are according to Marr *et al.* (2004) useful for mapping direct interrelationships and interdependencies but not for mapping indirect or less obvious interdepencies;
- It fails to identify performance measurements as a two-way process, since it focuses only on top-down performance measurement; and
- It is according Atkinson (2006) to rigid and limited in its definition of the customer perspective, and ignores other important stakeholders such as the employees, suppliers, alliance partners and the local community, i.e. it does not consider the extended value chain.

Despite the critique the BSC remains an important MCS artefact that is used by many organizations to assist them in the execution of their strategies. In Section 4.4.3.3, the application of the BSC within the context of Physical Asset Management is evaluated in more detail.

2.4.6.5 Six Sigma $(6-\sigma)$

Six Sigma $(6-\sigma)$ is a management approach aimed at improving the organization's products, services, and processes by continually reducing defects across all organizational processes. Motorola was the first organization to use the term $6-\sigma$ in the 1980s as part of its quality performance measurement and improvement program. Since then companies such as General Electric, Honeywell, and DuPont have been using $6-\sigma$ to improve business performance and annually realize millions of dollars in bottom line savings (Antony & Banuelas (2002); Snee & Hoerl (2003); Hoerl & Snee (2010)).

Raisinghani *et al.* (2005) defines $6-\sigma$ as a systematic, data-driven approach. From a statistical point of view Kwak & Anbari (2006) defines $6-\sigma$ as having less than 3.4 defects per million opportunities or a success rate of 99.9997% where Sigma is a term used to represent the variation about the process average. If an organization is operating at three Sigma level for quality control, this is interpreted as achieving a success rate of 93% or 66,800 defects per million opportunities. The $6-\sigma$ method is thus a very rigorous quality control concept where most organizations still performs at three Sigma level.

In their quest to reach $6-\sigma$ performance levels organizations normally apply the Define, Measure, Analyze, Improve and Control (DMAIC) methodology. The methodology consists of the following phases:

[1]Strategy maps are according to Banker *et al.* (2011) causal maps illustration relations between BSC performance measures and overriding strategic objectives. Strategy maps can aid managerial decisions if they enable managers to assess a measure's relative importance to the achievement of strategic goals (i.e., linkage to strategy) and thus provide cues for managers to weight and aggregate BSC measures in formulating an overall decision

1. (D)efine: Who are the customers and what are their priorities? Where are their problems? Which do we tackle first?
2. (M)easure: How is the process measured and how is it performing? What is its current state of performance?
3. (A)nalyze: What are the most important causes of performance failure?
4. (I)mprove: How do we remove the causes of poor performance?
5. (C)ontrol: How can we embed and maintain the improvements made?

$6-\sigma$ is often the target of criticism in the quality management community and characterized as *"Total Quality Management (TQM) on steroids"* (Goding & Hammer (2001)). Kwak & Anbari (2006) however pointed out in this regard that $6-\sigma$ is far more comprehensive than TQM and Continuous Quality Improvement (CQI). $6-\sigma$ includes according to these authors financial measures and results and the method uses additional, more advanced data analysis tools, focuses on customer concerns, and uses project management tools and methodology. They summarized the $6-\sigma$ management method as follows:

$$6-\sigma = \text{TQM} + \text{Stronger Customer Focus} + \text{Additional data analysis tools} + \text{Financial results} + \text{Project Management}$$

Kwak & Anbari (2006) identified four key elements of successful SS applications:

1. Management involvement and organizational commitment;
2. Project selection, management and control skills;
3. Encourage and accept culture change; and
4. Continuous education and training.

In addition hereto Gamal Aboelmaged (2010) conducted a literature review on over a 17 year period and included 417 referred journal articles in business and management disciplines, information systems and computer science, engineering, healthcare in his analysis. The most cited success factors in $6-\sigma$ literature included the following:

1. Selection of $6-\sigma$ projects;
2. Changing organizational culture;
3. Aligning $6-\sigma$ projects to corporate business objectives;
4. Cross-functional team working;

5. Effective communication;
6. Infrastructure (both organizational and IT infrastructure);
7. Training;
8. Linking $6-\sigma$ to business strategy, customer, HRM, suppliers;
9. Measurement;
10. Accountability;
11. Understanding tools and techniques within $6-\sigma$; and
12. Project management skills.

It is important to note these success factors because they are specifically considered in the development of the model for the early detection and prevention of PAM acrlongsef PAM Strategy Execution (see Chapter 6).

Successful $6-\sigma$ implementations has produced spectacular results and for this reason it will in all likelihood not just fade into the oblivion and just be remembered as another management fad. The focus of $6-\sigma$ should however not just be on defect elimination but on improving overall organizational performance. The application of $6-\sigma$ within the context of the contemporary AM organization is discussed in Section 4.4.3.3.

2.5 Conclusion

In this Chapter the most important emerging business strategy approaches, themes and challenges were introduced and contextualized. In Section 2.1 a categorization framework was introduced. This framework as well as the major theoretical contributions are presented in Table 2.9.

Table 2.9: Strategy Management – A framework for analysis

Period	Strategy Management	Organizational Design	Management Control Systems
The Modern Organization (1900 -1945)	• Very few theoretical contributions; • Market conditions relatively uncontrolled; • Adam Smith described market forces as an "invisible hand"; and • Firms did not really use or needed real strategic methodology.	FW Taylor conceptualize Scientific Management (SM). SM consisted of four principles: • Work methods are based on scientific study of task; • Scientifically train workers; • Provide detail instructions; and • Divide work and responsibility between Thinking and Doing.	Scientific Management principles assume that workers are of limited intelligence, innately idle and driven by the need for immediate gratification. Control systems within the Modern Organization was thus developed to support these ideas. Management Contol mechanisms were relatively simple and theoretical contributions in this time mainly focused on the development of of effective pay and reward systems.
The Bureaucratic Organization (1945 -1990)	• Strategy paradigms evolved from a corporate planning in the 1960's, to diversification and portfolio planning in the 1970's; • During the early 1980's the dominant strategy contributions the Industrial Organization (IO) movement. • During the late 1980's and early 1990's the focus shifted inward. The dominant discourse revolved the *"resource based view of the firm"*	The bureaucratic organization design was strongly influenced by the work of Max Weber. Organization design in this period is characterised by clearly defined organizational hierarchies and well defined Job Descriptions. A large proportion (if not the majority) of Contemporary Organizations are still characterised by Bureaucratic design principles.	Robert Anthony was the first exponent to present a framework for Strategy and Management Control. The control systems within the Bureaucratic Organization was however mainly focussed on: • Providing accounting information; • Individual responded to information; and • The formulation of defensive strategies.

Period	Strategy Management	Organizational Design	Management Control Systems
The Contemporary Organization (1990 - current)	The rate of change change increased dramatically and this led to the deconstruction of existing paradigms. the focus is no longer on the definition of a grand plan, but rather the continuous generation of innovative and new ideas that would surprise the competition and delight the customers.	Contemporary strategy pre-supposes the existence of an agile workforce that is on a continuous learning path. Clearly defined job descriptions – in which the "one best way" is typically defined and hierarchies is counter productive within this environment. CO are typically organic, flexible often temporary and highly adaptive to changing circumstances.	A large variety of management control systems and artefacts are used within the contemporary organization. In line with the fact that the organizational landscape is in a state of continuous flux control systems also evolve on a continuous basis to assist managers and decision makers. The complexity of the contemporary business landscape makes the development of an "ideal" MCS impossible.

In Section 2.2 the focus fell on the origins of business strategy and strategy management theory. It was illustrated that business strategy had its origins in warfare and that Sun Zsu already in 400BC described the importance of a superior strategy in the battle for resources between competing tribes and nations.

In Section 2.2.1 it was illustrated that very few theoretical contributions were made to the field of strategy management theory in the period 1900 – 1945. The adoption of strategic terminology in the business context had to await the so-called "Second Industrial Revolution" which only really took off after the WWII.

After WWII the application of new analytical tools and techniques, such as linear programming, cost benefit analysis and discounted cash flow techniques empowered managers to make better and more informed decisions. The pace of change and the level of competition between role-players increased dramatically. In Section 2.2.2 the major theoretical contributions during the Bureaucratic period was introduced. These contributions were discussed under the following headings:

- Strategy as corporate planning;
- Diversification and portfolio planning;
- Industry analysis and competition – The need for strategic management;
- The quest for competitive advantage;
- Developing and inventory of internal resources; and
- Resource cooperation and integration.

It was illustrated that changes in the external environment had an impact on the way in which strategy was conceptualized. Strategy paradigms evolved from a strong focus on corporate planning in the 1960's, in a time when the economy was characterized by mergers and the creation of large corporations. As organizational efficiency increased businesses increasingly embarked on diversification campaigns. This lead to the rise of so-called strategy consultants and the development of a number of portfolio planning models during the 1970's. During the early 1980's the dominant strategy contributions came from a sub-field of economics know as the Industrial organization (IO). During the late 1980's and early 1990's the focus shifted inward. The dominant discourse during this period revolved around what Barney (1991) described as the *"resource based view of the firm"*.

The technology boom of the late 1990's – characterized by the growth of the internet, mobile telephony and digitization – led to the introduction of new thinking on strategy. In Section 2.2.3 it was illustrated that the changes in the technology landscape introduced a rate of change unseen in any the foregoing periods. Theorists and practitioners alike started to questions and de-construct existing approaches and paradigms regarding not only strategy formulation but also organizational design archetypes. The existing paradigms and models were no longer adequate to support decision makers in what Ghezzi (2013) calls the age of discontinuity. In the final analysis it was also illustrated that the nature of contemporary strategy formulation also led to the realignment of behavioural and power dynamics within organizations.

Initially theorists argued that organizational design and structure was the result of environmental, technology and strategy changes. Later theorists argued a more interdependent relationship between strategy and structure. It was however stated that a detailed analysis of the relationship between strategy and structure fell outside the scope of the study.

In Section 2.3.1 the impact of FW Taylor and his conceptualization of Scientific Management was introduced. Despite the critique against many of the ideas propagated by Taylor the impact of his contribution is still seen in many contemporary organizations.

The nature and characteristics of the Bureaucratic Organization was discussed in Section 2.3.2. The contribution of Max Weber and the development of clearly defined organizational hierarchies was specifically highlighted. A large proportion (if not the majority) of Contemporary Organizations are still characterised by bureaucratic design principles.

Within the context of the CO where the need for continuous innovation and the generation of new ideas is essential, it is no longer possible to have a clear distinction between thinking and doing. In Section 2.3.3 it was noted that there is a growing trend towards the empowerment, emancipation and engagement of organizational members at all levels of authority and responsibility.

Strategy and Management Control Systems were discussed in Section 2.4. Systems thinking within the contemporary organization was firstly discussed in Section 2.4.1. The

issue of control as an organizational reality was then introduced in Section 2.4.2. The evolution of organizational control was then discussed in Sections 2.4.3, 2.4.4 and 2.4.5. The interdependence between developments in the fields of strategy, organizational design and control was clearly illustrated in this discussion.

This section was concluded with a brief discussion of some of the most important management control artefacts currently being used within contemporary organizations.

Although the strategy management approaches, themes and challenges discussed in this chapter do not follow a strict chronological order, many of the developments in the application of strategy is the result of changes in the very nature of competition and operations between and within businesses. It was thus illustrated that the relationship between strategy theory development and business operation is clearly Hegelian in nature. It thus often difficult to identify if changes in strategy management theory patterns is the result of changes in the nature of business or vice versa.

In the next Chapter the focus will fall on the challenges organization face after strategy has been formulated. Many organizations find themselves in a strategy crises, not because they chose the wrong strategy, but because they struggle to execute or implement[1] the strategy. In Chapter 3 the nature and extent of the strategy execution problem as well as contemporary contributions on addressing the problem will be evaluated.

[1]In this study as in most other studies on the topic the terms Strategy Implementation and Strategy Execution will by used interchangeably

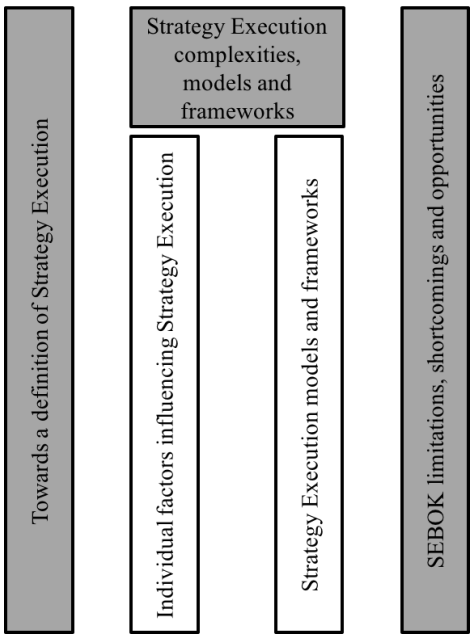
Chapter 3

Strategy Execution obstacles, challenges and failure

"Suit the action to the word, the word to the action"

William Shakespeare, Hamlet, Act iii. Sc. 2

Figure 3.1: Chapter 3 Outline



The complexities involved in the formulation of an agile strategy was illustrated in the preceding chapter. Implementing strategy throughout the organization however seem to

be even more difficult, and unlike strategy formulation, Strategy Execution (SE) is often seen as something of a craft, rather than a science, and its research history has previously been described as fragmented and eclectic (see Noble (1999b); Kaplan & Norton (2005), Hrebiniak (2008); Sull (2007) and Sull *et al.* (2015)).

Within the context of the recent global economic meltdown, the failure of so-called "too big to fail" corporations and a number of global corporate governance scandals, inconsistencies between intended and realized strategies have become more closely scrutinized. In addition to Strategy Execution failures reported on in mainstream media the fact that organizations struggle to execute their strategies is also evidenced by the results of a number of empiric studies that paint a rather bleak picture on the state of Strategy Execution (see Nutt (1999); Johnson (2004); Mankins & Steele (2005); Kaplan & Norton (2005); Crittenden & Crittenden (2008) and Sull *et al.* (2015)).

A number of contributors calls the inability organizations have to execute strategies the "Strategy Execution Gap" (see Floyd & Wooldridge (1992) Kaplan & Norton (2005); and Sull (2007)). Crittenden & Crittenden (2008) refers to the "habitual mode of poor Strategy Execution". According to them ineffective Strategy Execution (SE) contributes to poor performance. Poor performance is then often the catalyst for strategy review and reformulation. Unless this cycle is broken in time, the endless formulation-implementation-performance cycle will ultimately result in attempts at implementing a wrong strategy. When this happens, it is difficult to determine if poor performance is due to good implementation of a bad strategy, or the result of poor implementation of a good strategy.

According to Miller *et al.* (2004) the interaction between organization and strategy, has long been treated as something of a black box. The implication is thus that it is often very difficult or even impossible for executives to identify and explain why organizations perform either good or bad.

There has been up to the start of the contemporary strategy management period[1] very little deep and cohesive research on Strategy Execution. Alexander (1985) was one of the first contributors to point out that the overwhelming majority of strategy research in the bureaucratic period focused on the planning process itself or on the content of the strategy being formulated. He noted that although academics and practitioners often referred to the importance of the Strategy Implementation process very little research has been conducted by the mid 80's to understand the dynamics involved in the execution process. Noble (1999b) and Miller *et al.* (2004) concur and calls for research that explores the field of Strategy Execution in more detail. Despite the fact that a number of researchers seemed to have heeded the calls of Alexander (1985), Noble (1999b) and Miller (1997), Sull *et al.* (2015) are still of the contention that books and articles on strategy formulation outnumber those on execution by an order of magnitude.

All these authors are in agreement with the fact that a myriad of factors can poten-

[1]The contemporary strategy management period for the purpose of this study begin in 1990 as discussed in Chapter 2.

tially affect the process by which strategic plans are turned into organizational action. They suggest that instead of concentrating on the macro perspectives which focus on the content of strategic initiatives, the debate should shift towards more micro perspectives which emphasize how strategy is put into practice. The activity–based view of strategy proposed by Miller *et al.* (2004), argues that since managers manage strategic actions, academics and practitioners need to go inside organizations to understand what they are doing.

Strategists use interesting terminology and analogies to describe the importance of – and challenges involved in the Strategy Execution process. Some like Eisenstat & Beer (2000) and Mankins & Steele (2005) use confrontational and even sometime warfare terms such as "dealing with strategy killers" and "the need to conquer the gap between strategy and performance". Others such as Porter & Harper (2003) use sports analogies such as "blocking and tackling", and suggest that managers must "hone their implementation skills". Weick (1995) believe managers should "walk the talk" and Simons & Roberson (2003) believe managers should show "word–deed alignment". Crittenden & Crittenden (2008) are of the contention that Strategy Implementation is not an opponent that needs to be conquered or tackled. They argue that Strategy Implementation is a "critical cornerstone and ally" in the building of a capable organization.

It is important to note that the relatively large body of knowledge on the topic of Strategy Control (referred to in Section 2.4 should not be confused with Strategy Execution. Strategy and Management Control systems and processes provides important feedback (mostly after the fact), regarding the effectiveness of the strategy. The existence of a strategy control system is however no guarantee that strategy will be executed nor does it provide sufficient explanations on why strategies were not executed. In this study a clear distinction will thus be made between Strategy or Management Control, and Strategy Execution. For the purpose of this study the inability organizations have to execute strategy will be referred to as Strategy Execution Failure (SEF).

This chapter has the following objectives:

1. Define and contextualize the concept Strategy Execution (and by implication Strategy Execution Failure (SEF)) (see Section 3.1);
2. Analyze the recent empirical and theoretical contributions regarding SEF (see Section 3.2); and
3. Discuss the limitations and shortcomings of the existing Strategy Execution Body of Knowledge (SEBOK) (See Section 3.3).

A review of the literature reveals no generally accepted definition of Strategy Execution. In the next section Strategy Execution will be defined and contextualized.

3.1 Towards a definition for Strategy Execution

In the quest to find an acceptable definition for Strategy Execution (SE)[1] that can be used as reference point for the purpose of this study, fundamental questions regarding the correlation between organizational performance and Strategy Execution were raised. The intuitive assumption is that there is a strong correlation between corporate performance and Strategy Execution. Good corporate performance thus indicates successful Strategy Execution while poor corporate performance is an indication of unsuccessful Strategy Execution.

Miller (1997) however finds this correlation somewhat contentious and potentially problematic because corporate performance is the result of a range of complex and interrelated elements. Dean & Sharfman (1996) concur and state that a firm's performance is a function of a diverse array of factors. For this reason Miller (1997) is of the opinion that corporate performance is not necessarily an indication of successful Strategy Execution. These authors thus argue that in the presence or absence of good corporate performance it is critically important to understand the functioning of, and relationship between, the complex elements of a strategy. Without such an understanding it would be impossible to ensure sustainable and repeatable Strategy Execution.

If it is accepted that corporate performance is not in itself the only indication of successful Strategy Execution an alternative set of criteria is required. Miller (1997) suggests that SE success should be evaluated according to the following criteria:

- *Completion* – Refers to how far the decision was implemented within a given time period. Strategies are often only partially implemented or take far longer than intended as was found in the study by Alexander (1985). (See Section 3.2 below).
- *Achievement* – Refers to the degree to which the implemented strategy lives up to the expectations. Achievement is thus a performance measure and indicates how far the objectives of those who formulated the strategy was met; and
- *Acceptability* – In some instances strategies are implemented as intended, on time and within budget (Achievement), the strategy may also meet all predefined objectives (Completion) but is so unpopular that it cannot be acclaimed an unmitigated success (Acceptability). According to Miller (1997) the first two criteria can be viewed as somewhat more impersonal with information derived from objective information. Acceptability is however a more personal evaluation of success.

The criteria is useful because it ensures a more comprehensive definition of success and will be used throughout this study when the successfulness of Strategy Execution is evaluated.

[1] In the literature the terms Strategy Implementation and Strategy Execution are used interchangeably. In their review of 60 articles, Yang *et al.* (2009) found no differentiation between Strategy Implementation and Strategy Execution. For the purpose of this study the terms will also be used interchangeably, although preference will be given to the use of the term Strategy Execution.

Noble (1999b) did a comprehensive literature review of Strategy Implementation research in 1999. Although this study was conducted nearly two decades ago Noble's findings as well as the organizing framework he used for the purpose of his review is still relevant.

Noble (1999b) identified the following broad perspectives on Strategy Execution:

1. *Execution as operationalization* – The most common definition describes execution as a straightforward operationalization of a clearly articulated strategic plan;
2. *Execution as a set of behaviours* – Researchers such as Cyert *et al.* (1963) have emphasized the importance of more interpersonal and behavioral elements when discussing implementation;
3. *Execution as control* – The treatment of execution as synonymous with control is a common perspective in many business strategy texts. The best example of this treatment can be found in the work by Hrebiniak & Joyce (1985). The authors view implementation explicitly as an act of control and monitoring;
4. *Execution as detailed planning* – Finally, several authors (e.g. Cespedes & Piercy (1996) and Laffan (1983)) view execution as a finer level of planning involving the allocation of resources and the resolution of operational issues.

Noble (1999b) however concludes his study by suggesting a simplified strategy executing research framework that consist of only two dimension:

1. *The structural view*: The focus here is on the effects the formal organizational structure and control mechanisms has on implementation processes and outcomes; and
2. *The interpersonal process view*: The focus here is on the effects aspects such as strategic consensus, behaviours, organizational climate, communication and interaction processes has on execution and outcomes.

He suggest that SE scholars should consider these categories or dimensions when reviewing SE research and practice.

In their literature review on the factors influencing Strategy Implementation, Li *et al.* (2008) seem to agree with Noble and also suggest that SE has both a structural or process component[1]. In addition to these two perspectives Li *et al.* (2008) however suggest a 3^{rd} perspective they call the "hybrid perspective" that essentially combines the process perspective and the behaviour or action perspective.

[1] *The process perspective*, takes SE as a sequence of carefully planned consecutive steps; *The action perspective*, takes SE as a series of more or less concerted actions and examines these actions from a behaviour perspective; as well as interpersonal or action perspective.

Crittenden & Crittenden (2008) confirm the importance of the structural and behavioural dimensions. According to them Strategy Implementation is comprised of structures and managerial skills:

1. Companies operate within a framework that is provided by structures; and
2. Managers engage with subordinates within the parameters of these structures utilizing a variety of skills. Managerial skills are thus according to these authors an important pre-requisite to ensure successful Strategy Execution.

In addition to the fact that Crittenden & Crittenden (2008) identify and contextualize these important dimensions they also identify eight Strategy Implementation levers to assist executives in the development of a capable organization. Theses levers are discussed in more detail in Section 3.2.

The dimensions identified by Noble (1999b), Li *et al.* (2008) and Crittenden & Crittenden (2008), will not only be considered in distilling a definition for Strategy Execution for the purpose of this study, it would also be referred to in Section 3.2 when the nature and causes of the SEG is evaluated in more detail. The conclusion reached by all these contributors are however that Strategy Execution is a multifaceted and complex organizational process and that there are a wide range of related research areas that may have worthwhile implications for its study.

Considering the Strategy Execution success criteria (see Miller (1997) as well as the various perspectives found in the literature or Strategy Execution (see Li *et al.* (2008), Noble (1999b), Hrebiniak (2008); and Laffan (1983)) it is important to consider both the process and outcome of the Strategy Execution process when a definition is formulated. For the purpose of this study, Strategy Execution will have the following definition:

> Strategy Execution refers to the continuous process during which an organization critically evaluates and adjusts:
>
> - The applicability of its organizational design and management systems (including control mechanisms); and
> - The readiness of its interpersonal processes (such as strategic consensus, behaviours, organizational climate and communication),
>
> in order to ensure the acceptable completion, achievement and stakeholder acceptance of strategic objectives.

In the next section contemporary SE literature will be evaluated in more detail.

3.2 Strategy Execution complexities, models and frameworks

"...things that are supposed to happen, don't happen..."

Charan *et al.* (2012)

As indicated in the introduction to this chapter Strategy Execution Failure (SEF) reported on in mainstream media as well as in a number of empiric research studies paint a rather bleak picture on the state of Strategy Execution. In a study of 358 decisions in medium to large organizations in the U.S. and Canada, Nutt (1999), found that 50% of the strategic decisions failed. In a study done by Johnson (2004) he found that 66% of corporate strategy is never implemented. Allio (2005) refers to a study done by the Economist over a three year period in which it was found that a discouraging 57 % of firms were unsuccessful at executing strategic initiatives. Mankins & Steele (2005), report that companies only realize 63% of the financial performance promised by their strategies. In a survey of 156 large organizations also conducted by Mankins & Steele (2006) they however found that executives often make strategic decisions outside the planning process, in an ad hoc fashion and without rigorous analysis or productive debate.

Results of a study conducted by Kaplan & Norton (2005) found that up to 95% of company employees were unaware of the strategy. The results of far more recent surveys confirms the Strategy Execution challenges contemporary organizations are facing. In their Global Performance Alignment Survey, PWC (2014) found that although 76% of global CEO's agree that their leadership team shares a consistent view of the strategic priorities, only 54% believe their strategy has been sufficiently translated into clear actions that will achieve their objectives. In another study of more than 400 global CEO's, Sull *et al.* (2015) found that the most important challenge facing corporate leaders in Asia, Europe, and the United States was the issue of Strategy Execution.

The purpose of this section is to evaluate the nature and extent of contemporary SE contributions in more detail. A number of SE contributions have been made over the past three decades. In their review of Strategy Implementation research over a period of 25 years Yang *et al.* (2009) identified two streams of Strategy Execution research. The first stream focus on the identification of individual factors that influence Strategy Execution. The second stream focus on the presentation of models to illustrate how individual factors interrelate to form a Strategy Execution environment. Authors from both the first and the second stream normally conclude their studies with the presentation of relatively logical suggestions to address the Strategy Execution challenges retrospectively. In the following paragraphs contemporary Strategy Execution contributions[1] will be evaluated critically under the following headings:

[1]A number of models and tables developed by these contributors will reproduced. These models and tables are included for ease of reference and to assist readers to follow the development of the arguments and conclusions reached in this chapter.

- In Section 3.2.1 contributions regarding individual factors influencing Strategy Execution failure is presented;
- In Section 3.2.2 integrated Strategy Execution frameworks and models are presented; and

The next section is dedicated to a presentation of the most important individual factors influencing the Strategy Execution process as identified by contributors over the past three decades

3.2.1 Individual factors influencing Strategy Execution

Alexander (1985) was one of the first contributors to point out that the overwhelming majority of strategy research focused on the planning process itself or on the content of the strategy being formulated. He noted that although academics and practitioners often referred to the importance of the Strategy Implementation process very little research has been conducted by the mid 80's to understand the dynamics involved in the execution process.

In his initial study on the topic of Strategy Implementation, Alexander (1985) surveyed 93 private sector firms through a questionnaire to determine which implementation problems occurred most frequently as they tried to put strategic decisions into effect. Later on, in-depth telephone interviews with CEOs of 21 of these firms were conducted to comprehend these problems more fully. The ten execution obstacles that were mentioned most frequently in the Alexander study are reflected in Table 3.1:

Table 3.1: Alexander's Execution Obstacles

1. Implementation took more time than originally allocated;
2. Major problems surfaced during implementation that had not been identified beforehand;
3. Coordination of implementation activities was not effective enough;
4. Competing activities and crises distracted attention from implementing this decision;
5. Capabilities of employees involved were not sufficient;
6. Training and instruction given to lower level employees were not adequate;
7. Uncontrollable factors in the external environment had an adverse impact on implementation;
8. Leadership and direction provided by departmental managers were not adequate enough;
9. Key implementation tasks and activities were not defined in enough detail; and
10. Information systems used to monitor implementation was not sufficient.

Reproduced from Alexander (1985).

Miller (1997) conducted an empirical study aimed at elucidating reasons for success or failure of strategic decisions. She evaluated eleven decisions across six organizations. Ten factors were deduced by her from the data. These factors are reflected in Table 3.2. The first four is within the organization's control while the fifth factor relates to circumstance beyond the direct control of the organization. Miller (1997) calls these factors "realizers" since they help the organization to realize the highest degree of success during implementation. The other five factors are called "enablers" since they support successful execution without really being able to fully realize success.

Table 3.2: Miller's reasons for strategic decision success and failure

- **Realizers**
  1. Backing – The degree to which influence patterns favour implementation;
  2. Accessibility – The degree to which success of implementation can be evaluated with precision;
  3. Specificity – The degree to which presise details of implementation tasks and activities were decided before hand;
  4. Cultural receptivity – The degree to which organizational culture is conducive to implementation; and
  5. Propitiousness – The degree to which any un-forseen external circumstances favour implementation.
- **Enablers**
  1. Familiarity – The degree to which those involved have experience relevant to implementation;
  2. Priority – The degree to which implementation is given precedence in the organization;
  3. Resource availability – The degree to which resources (manpower, finance and time) is available;
  4. Structural facilitation – The degree to which the organizational structure is condusive to implementation; and
  5. Flexibility – The degree to which the implementation process can be adapted to accommodate chaning circumstances

Reproduced from Miller (1997)

Eisenstat & Beer (2000) uses the analogy of cholesterol when describing what they refer to as the six silent killers of Strategy Implementation and learning. In the same way cholesterol blocks the human arteries with no outward symptoms, organizations also have silent killers working below the surface preventing strategies from being implemented.

Eisenstat & Beer (2000) conducted their research for more than a decade using an inquiry and action–learning method they call "Organizational Fitness Profiling" (OTP).[1]

The researchers included twelve companies consisting of no less than 150 business units in their study. The six factors that were identified by them as killers of Strategy Execution are reflected in Table 3.3.

Table 3.3: Six silent killers of Strategy Execution

- Top–down or laissez-faire management style;
- Unclear strategy and conflicting priorities;
- An ineffective senior management team;
- Poor vertical communication;
- Poor co–ordination across functions, businesses and borders; and
- Inadequate down–the–line leadership skills and development.

Reproduced from Eisenstat & Beer (2000)

As indicated in Section 3.1, Crittenden & Crittenden (2008) identified eight Strategy Implementation levers to assist executives in the development of a capable organization. These eight levers are divided into structure and skills.

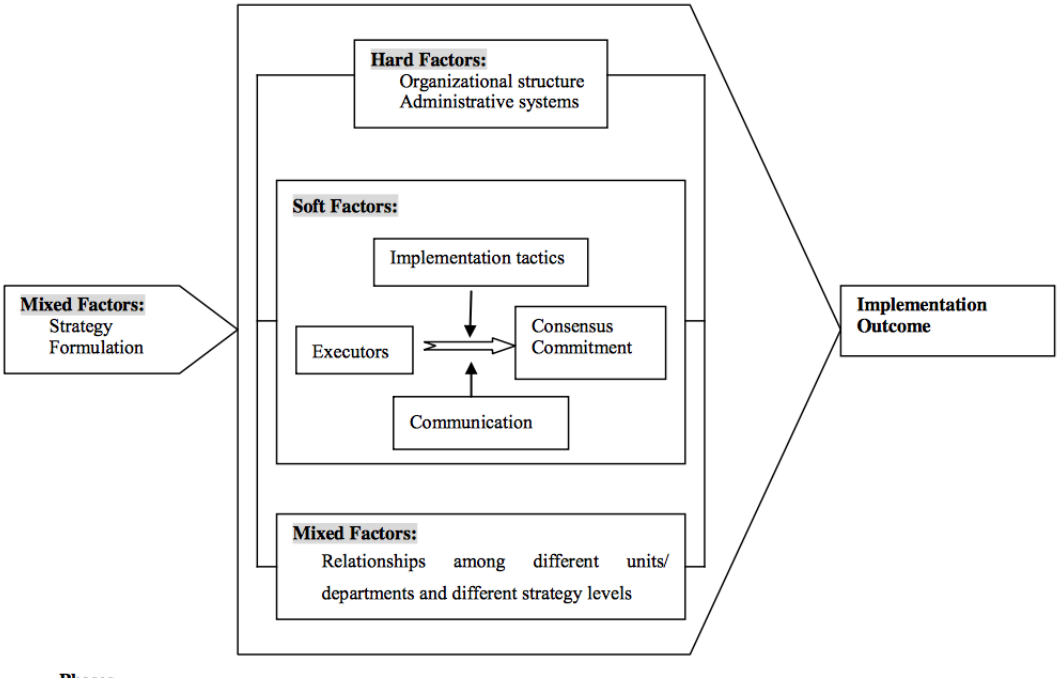
- Structural variables are:
  1. Actions – who, what and when of cross-functional integration and company collaboration;
  2. Programs – instilling organizational learning and continuous improvement practices;

[1]OTP is both an intervention method and a research approach. It unfolds over a series of meetings intended to promote an open and fact based dialogue within the senior management team of an organizational unit, as well as between the top and lower organizational levels. The process involves five steps:

- Create a statement about direction;
- Collect data on barriers and strengths;
- Develop an integrated plan for change;
- Refine the plan; and
- Implement the plan.

A more detailed discussion of OTP falls outside the scope of this section, but elements of the OTP are used as part of the research methodology in this study.

Figure 3.2: Nine recurring factors influencing Strategy Implementation



Adapted from Yang et al. (2009).

3. Systems – installing strategic support systems; and
4. Policies – establishing strategy supportive policies.

- Managerial variables are:

5. Interacting – the exercising of strategic leadership;
6. Allocating – understanding when and where to allocate resources;
7. Monitoring – tying rewards to achievement; and
8. Organizing – the strategic shaping of corporate culture.

In their literature review of 60 studies on the factors influencing Strategy Implementation Yang *et al.* (2009) identified nine recurring, individual factors that influence Strategy Implementation. The distillation done by Yang *et al.* (2009) is found to be particularly useful for the purpose of this study. These factors were divided into mixed, soft and hard factors. These nine factors are depicted in Figure 3.2.

In the following paragraphs these nine factors are discussed in more detail.

Mixed factors

1. *Strategy formulation* – In the preceding chapter the importance of strategy was discussed in detail. In addition to this expose of strategy formulation contributions several studies mention the importance of strategy formulation as a pre-requisite for Strategy Execution (see Hrebiniak & Joyce (1985); Alexander (1985); Allio (2005); and Martin (2010)). These contributors are all in agreements that the formulation of strategy that is consistent and fitting are extremely important pre-requisites for for successful Strategy Implementation. They furthermore emphasize that poorly defined strategy will without any doubt limit the execution efforts significantly. The food analogy made by Allio (2005) is very appropriate within the context:

   > *...good implementation naturally starts with good strategic input in the same way that soup is only as good as the ingredients...*

   In his study, Martin (2010) finally debunks the idea that a poor strategy implemented well is always better than a good strategy implemented poorly.

2. *Cross departmental relations* – Relationships among different units and departments and different strategy levels are identified by many contributors as a significant factor influencing the Strategy Execution process (see Slater & Olson (2001); Chimhanzi (2004); and Chimhanzi & Morgan (2005)). The following three aspects of the business unit relationships seem to have the biggest potential impact on successful Strategy Execution:

   - Business unit autonomy – Within the context of the contemporary organization agile teams with high levels of autonomy seem to be more effective (these findings are in line with the discussion in Section 2.3.3 on general contemporary organizational design and Asset Management organization design in Section 4.4.2.3);
   - Goal alignment across strategy levels and Strategic Business Unit (SBU) – Unit autonomy without alignment is a recipe for conflict and will have detrimental impact on Strategy Execution. Chimhanzi & Morgan (2005)'s findings indicate that firms devoting attention to goal alignment between SBU are able to realize significantly greater successes in their Strategy Implementation; and
   - Control and reward systems – Control and reward systems should facilitate the elimination of conflict of interest and the break down of cross departmental silo's. These systems should be designed in such a way that team members understand that cross departmental objectives are often interdependent. Rewards should thus ideally only be awarded when organizational as opposed to departmental goals are achieved.

Soft factors

3. *Executors of strategy* – Executors refer to the people within the organization responsible for the execution of strategy and include, top management, middle management, junior management as well as non-management staff. A number of studies conclude that executors has a very important if not the most important impact on Strategy Execution success (see Peng & Litteljohn (2001); Rapert *et al.* (1996); Lehner (2004) and Boer *et al.* (2005)).

   Although there is a number of studies emphasizing the role of senior management in the Strategy Execution process (see Hrebiniak & Snow (1982); Harrington (2006); Schmidt & Brauer (2006) and Schaap (2012a)). Yang *et al.* (2009) are however of the opinion that weak empirical evidence exist to confirm this hypothesis and they call for more empirical research to clarify the role of top management in the Strategy Execution process.

   It is according to Yang *et al.* (2009) possible to identify three viewpoints regarding the role of middle-management in the Strategy Execution process These viewpoints are discussed below:

   (a) The Strategy-Style Matching Theory (SSMT) was first proposed by Slater (1989). The theory propose that effective Strategy Execution requires middle management to have managerial and leadership styles and strengths that are consistent with the competencies required by the strategy. A *differentiation strategy* would for example require managers to have a high internal locus of control in the pursuit of product innovation, while *build strategies* required willingness to accept risk and tolerance for ambiguity. These characteritics however hampered effectiveness in *harvest strategies*.

   (b) The effect of context on behaviour – It is according to Walderseel & Sheather (1996) widely accepted that different strategies require middle managers to adopt different kinds of behaviour. Walderseel & Sheather (1996) is of the opinion that results of various studies on the impact personality traits and leadership styles has on organizational effectiveness are inconclusive at best. The only exception being intelligence.

   Walderseel & Sheather (1996) like other interactionists[1] have argued that actions are a function of internal (e.g. personality) as well as external (e.g., situation) factors. In their analysis they rely strongly on the work done by Mischel (1973). He makes a distinction between so-called strong and weak situations and according to him strong situations lead people to construe events in the same way and produce uniform expectations regarding appropriate response patterns. In strong situations, personality thus plays a relatively small

[1]Interactionism is a theoretical perspective that derives social processes (such as conflict, cooperation, identity formation) from human interaction. It is the study of how individuals act within society. Interactionist theory has grown in the latter half of the twentieth century and has become one of the dominant sociological perspectives in the world today. George Herbert Mead, as an advocate of pragmatism and the subjectivity of social reality is considered a leader in the development of interactionism (Marshall (1994)).

role. In weak situations, individual differences such as personality can however determine behaviour more strongly.

In studies done by Walderseel & Sheather (1996) the same group of managers seem behave differently when confronted with different strategies. When the group of managers were presented with an entrepreneurial strategy they intuitively understood the need to be more participative and persuasive in their leadership style, to focus on the specialist staff who are crucial to innovation, to focus on the technology, and to restructure the organization.

When presented with a conservative strategy managers they same group of managers became far more concerned about efficiencies and internal marketing of the change program to gain commitment rather than persuasion. Their study demonstrates, at least in a laboratory setting, that strategy plays a significant role in shaping managers intentions. Managers can alter their behaviours to suit different strategy situation.

(c) A number of studies explore the impact of relationships between top management and middle management on the effective execution of strategy (see Floyd & Wooldridge (1997) and Wooldridge & Floyd (1990)). The conclusion is that middle managers often find themselves in an emotionally awkward position – although they expect top management direction, they frequently feel that they are in a better position to start and evaluate alternative courses of action. In those organizations where senior and middle management firstly acknowledge this dilemma and secondly are able to strike a balance between the need for control and provision of direction on the one hand and allowance for flexibility on the other, Strategy Execution efforts seem to be more successful.

Strategic decisions are formulated by senior-level managers, and then imposed on lower-level management and non-management employees. Despite the fact that numerous studies emphasize the importance of employee commitment (a detail discussion on the impact staff commitment has on strategy is presented below), very few empirical studies focus on the specific impact lower management and non-management staff has on Strategy Execution.

Alexander (1985) is of the opinion that the following three factors related to lower level management and non-management staff, has a potentially negative impact on Strategy Execution: employees have insufficient capabilities to perform their jobs, lower–level employees are inadequately trained, and departmental managers provide inadequate leadership and direction. Nutt (1999) is of the opinion that in addition hereto the lack of strategic communication and knowledge sharing further complicates the role this group of stakeholders can play in the Strategy Execution process.

4. *Communication* – Organizational communication is central to most organizational processes including training, knowledge management and learning. The impact organizational communication has on the Strategy Execution process has been emphasized in a number of studies (Alexander (1985); Rapert *et al.* (1996); Rapert

et al. (2002); Foreman & Argenti (2005) and Kellermanns *et al.* (2005)). In these studies communication is mentioned more frequently than any other single item promoting successful strategy. Alexander (1985) is of the opinion that strategy communication should include include aspects such as:

- Clear explanation of responsibilities, tasks and duties;
- Clear explanations regarding the rationale behind organizational changes; and
- Clear explanations regarding the rationale behind strategic decisions.

Rapert *et al.* (2002) confirm the findings made by Alexander (1985) and their research confirms that organizations where employees have easy access to management through open and supportive communication climates tend to outperform those with communication environments that are less transparent and supportive.

It is often assumed that staff members in organizations are fully aware of, understand and accept the organizational strategy. This assumption is however in most instances not true as communication barriers are reported more frequently than any other type of barriers, such as organizational structure barriers, learning barriers, personnel management barriers, or cultural barriers. (Noble (1999b); Foreman & Argenti (2005); Kellermanns *et al.* (2005) and Yang *et al.* (2009)).

Non-effective communication typically has the following symptoms:

- Lack of alignment between the top executive's view of the strategy and the views of other organizational members;
- Lack of cohesion between departments; and
- Lack of consensus on priorities;
- Low staff commitment (see a detailed discussion on staff commitment below) levels;

.

Effective Strategy Execution thus requires and in-depth understanding of the causes of these symptoms as well as methods to address these. A detailed evaluation of communication strategy design however falls outside the scope of this study. In the next paragraphs consensus and commitment will be discuss as two separate factors influencing the Strategy Execution process. Both theses constructs are highly complex and interrelated. In line with the analysis done by Yang *et al.* (2009) they will however be treated as separate constructs.

5. *Consensus* – Floyd & Wooldridge (1997) define strategic consensus as:

> *"...the agreement among top, middle–, and operating–level managers [the executors] on the fundamental priorities of the organization...."*

In addition to their definition Floyd & Wooldridge (1992) developed a very useful framework to describe the strength of consensus within a given environment. Two variables should according to them be considered when evaluating levels of strategy consensus within an organization namely understanding and commitment. In order to determine strategy consensus levels both the depth of strategy understanding as well as the extent to which stakeholders are committed to the strategic priorities, should be considered. Their framework is illustrated in Table 3.4:

Table 3.4: Levels of strategy consensus

	Limited understanding	**In-depth understanding**
Weak commitment	Weak consensus	Informed sceptisism
Strong commitment	Blind devotion	Strong consensus

Adapted from Floyd & Wooldridge (1992).

The importance of strong strategy consensus is confirmed by a study done by Dooley *et al.* (2000) in which they reported that strongly committed teams were far more successful at executing decisions. It should however be noted that their findings also suggest that higher levels of commitment often resulted in slower implementation.

The risks that a lack of shared understanding of strategy priorities may have during the Strategy Execution process was also specifically noted by Noble (1999b).

6. *Commitment* – Despite the emphasis Floyd & Wooldridge (1997) place on strategic consensus (see discussion above) they also guard against shared understanding without commitment. Over the years a number of studies on the highly complex construct of employee commitment has been conducted. The Three Component Commitment Model (TCCM), developed by Meyer & Allen (1991) has been tested extensively and has received considerable support (see Meyer *et al.* (2002)), for detailed reviews. According to their model, commitment take three forms, each characterized by a different psychological state or mindset. The TCCM is illustrated in Table 3.5.

Table 3.5: The TCCM framework

Commitment Type	**Description**	**Performance Impact**
Affective Commitment (AC)	Reflects an emotional attachment and desire to remain with the organization	AC is expected to have the strongest positive effects on in-role and discretionary performance
Normative Commitment (NC)	Is experienced as a sense of obligation to remain	NC has an impact on performance but the impact is not as strong as AC.
Continuance Commitment (CC)	Reflects an awareness of the costs associated with leaving	CC is expected to be unrelated or negatively related to discretionary performance.

Reproduced from Meyer et al. (2002).

Noble & Mokwa (1999) also identifies three dimensions of commitment that according to them directly influence strategic outcomes. Their model is illustrated in Table 3.6.

Table 3.6: Commitment types and Strategy Execution

Commitment Type	**Description**
Organizational Commitment (OC)	The extent to which a person identifies with and works toward organization-related goals and values.
Strategy Commitment (SCM)	The extent to which a manager comprehends and supports the goals and objectives of a marketing strategy.
Role Commitment (RC)	The extent to which a manager is determined to perform his individual implementation responsibilities well, regardless of his beliefs about the overall strategy.

Adapted from Noble & Mokwa (1999).

There seem to be some disagreement amongst theorist regarding the exact definition of the staff commitment. Despite the apparent disagreements on the exact definition of commitment all contributors are in agreement that the Strategy Execution process is at risk if the strategy does not enjoy the support and commitment of the majority of employees and middle management (Alexander (1985); Noble (1999b); Rapert *et al.* (2002) and Heracleous (2000)). It is thus of the utmost importance that strategy decisions makers are able to identify symptoms of non-commitment. A number of studies in this regard has been done over the years. A detailed discussion on the construct of staff commitment as well as the symptoms of non-commitment however falls outside the scope of this study. For the purpose of this study the non-commitment symptoms defined by Branham (2012) and Guth & MacMillan (1986) are included.

In their study on reason why employees leave organizations, Branham (2012) identifies the following seven reasons:

(a) The job or workplace was not as expected;

(b) There is a mismatch between the person and the job;

(c) Too little coaching and feedback;

(d) Too few growth and advancement opportunities;

(e) Feeling devalued and un-recognized;

(f) Stress from overwork and work – life imbalance; and

(g) Loss of trust and confidence in senior leaders.

Guth & MacMillan (1986) identified three different sources of low to negative individual manager commitment to implementing a particular strategy:

(a) Low perceived ability to perform successfully in implementing that strategy;

(b) Low perceived probability that the proposed outcomes will result, even if individual performance is successful;

(c) Low capacity of the outcome to satisfy individual goals/needs.

All these factors should be treated as non-commitment symptoms and their presence within an organization should alert decision makers. Addressing these factors is however complex and requires and in-depth understanding of their causes. The research done in this field however concludes that non-commitment will have a detrimental impact on an organizations ability to execution strategy and performance in general.

7. *Implementation tactics and change management* – In their analysis Yang *et al.* (2009) refer to a number of studies on the effect of implementation tactics on the Strategy Execution process (see Nutt (1986); Nutt (1999); Bourgeois & Brodwin (1984); Lehner (2004); Sashittal & Wilemon (1996); Akan *et al.* (2006)). A closer review of tactics identified in these studies point to the fact that these studies form part of the Organizational Change Management Body of Knowledge (OCMBOK). For the purpose of this study implementation tactics will thus be referred to as Change Management Tactics (CMT).

   The OCMBOK is extensive and a huge amount of research has over the years been done in the field. Barnard (1938) for example already noted in 1938 that:

   > *"... organizations are cooperative systems that rely on the willingness of members to behave in ways that support the organization..."*

   and Cyert *et al.* (1963) concluded that:

   > *"...peoples personal goals often differ from those of the organization, and a primary responsibility of managers is to persuade members to direct their efforts toward organizational goals..."*

   For the purpose of this discussion a detailed evaluation of change management is however not required. In the next paragraphs generally accepted change management tactics will be noted.

   The analysis of the OCMBOK points to the facts that two forms of CMT are used, hard and soft or direct and indirect tactics. In Table 3.7 some of these tactics are discussed in more detail.

Table 3.7: Change Management Tactics

Tactic Type	Change Tactic	Description
Hard Tactics	Intervention	Intervention refers to strategy adjustments during the implementation stage by introducing new norms and practices (Nutt (1986); Nutt (1999)).
	The Commander Model	The first approach addresses strategic position only, the CEO use economic and competitive analyses to plan resource allocations to achieve his/her goals (Bourgeois & Brodwin (1984)).
	Edict	Edict tactics relies on power and is characterized by absence of participation and includes the issuing of directives (Nutt (1986)).
	Sanctions	This approach implies that managers threaten to punish employees for noncompliance through reprimands or with holding desired rewards (Hinkin & Schriesheim (1990)).
	Legitimization	Managers who use legitimization tactics seek to establish the credibility of a request by claiming the authority or right to make it or by verifying that it is consistent with organizational policies, practices, or traditions (Kochanowski *et al.* (2010)).
Soft Tactics	The Collaborative Model	This model concentrates on group decision-making at a senior level and involves top management in the formulation process to ensure commitment Bourgeois & Brodwin (1984).
	Paticipation	Participation consists of articulating strategic goals and nominating a task force that develops and proposes corresponding implementation options (Nutt (1986); Yang *et al.* (2009)).
	The Cultural Model	Exponents of this approach tries to implement strategy through the use of a corporate culture Bourgeois & Brodwin (1984).
	Ingratiation	Managers provide praise for employee efforts (Furst & Cable (2008); Falbe & Yukl (1992)).
	Consultation	Managers ask employees to provide suggestions or assistance in carrying out a change (Kochanowski *et al.* (2010); Furst & Cable (2008)).
	The Crescive Model	This approach draws on managers inclinations to want to develop new opportunities as see them in the course of their day-to-day management (Bourgeois & Brodwin (1984)).
	The change model	The Change model emphasizes how the organizational structure, incentive compensation, control systems and so forth can be used to facilitate the implementation of a strategy (Bourgeois & Brodwin (1984)).
	Persuasion	Persuasion consists of the tactic of using the involved parties to convince employees about the decided course of actions (Nutt (1986); Yang *et al.* (2009)).

Despite the vast amount of research on the topic of CMT, research is still inconclu-

sive about how the use of these tactics affect employee resistance to change. The conclusion reached by most of these studies is however that:

- The employment of CMT should not be done in isolation and practitioners should considers factors such as the organizational culture, the extent of change, and the characteristics of the role-players involved, when designing a change management campaing;
- Different circumstances thus require the use of different tactics;
- The employment of change management tactics is not a magic wand that can be used to ensure that organizational members behave in ways that support the organization

In the next paragraphs the focus will fall on the so-call Hard factors impacting on the Strategy Execution process as identified by Yang *et al.* (2009).

Hard factors

8. *Organizational design* – Factors relating to the organizational design are according to Heide *et al.* (2002) after communication (see discussion above) the second most important Strategy Implementation barrier. The dynamics involved in organizational design has however been evaluated in detail in Section 2.3 and will not be repeated in this section. Suffice to note that appropriate organizational design is an essential aspect to consider during the Strategy Execution process.

9. *Administrative systems and Management Control Systems* (MCS) – The importance of administrative and MCS has been evaluated in detail in Section 2.4 and will not be repeated in this section. Suffice to note that appropriate MCS is an essential aspect to consider during the Strategy Execution process.

The list of nine factors discussed above is off course also not completely comprehensive. There are a number of other factors also mentioned in studies but not always analyzed in–depth. These factors include:

- Organizaationl culture (Heracleous (2000); Heide *et al.* (2002) and Schaap (2012b));
- Firm size (Harrington (2006);
- The external or general market environment (Alexander (1985);
- Power structures (Hrebiniak & Joyce (1985); and Hrebiniak (2008)); and
- Reward and recognition schemes (Schaap (2012b)).

It is indeed tempting to distill yet another list of recurring individual factors that influence the SE process. This is however not the focus of this study. The identification of all these factors are important and their validity is accepted. The identification of these factors indeed contributes to the creation of higher levels of consciousness among academics and practitioners. It is however doubtful whether the presentation of these factors in which ever format will in itself lead to the early detection and prevention of Strategy Execution Failure.

In the next section models illustrating the interrelationships between individual factors are evaluated in more detail.

3.2.2 Strategy Execution models and frameworks

It was indicated in the introduction to Section 3.2 that Yang *et al.* (2009) identified two streams of Strategy Execution research in their review of Strategy Implementation research over a period of 25 years. The first stream focus on the identification of individual factors that influence Strategy Execution. These factors were discussed in Section3.2.1. The second stream focus on the presentation of models to illustrate how individual factors interrelate to form a Strategy Execution environment. Contributors in the second group compiled multiple factors in a framework or model (Noble (1999a); Eisenstat & Beer (2000) Higgins (2005) Qi (2005); Brenes *et al.* (2008); Sull (2007); Crittenden & Crittenden (2008)). Higgins (2005); Brenes *et al.* (2008) and Eisenstat & Beer (2000), developed models illustrating the relationships between various individual factors impacting on Strategy Execution. Noble (1999a); and Sull (2007) provided useful advice on addressing some of the complexities involved in the SE process.

In the Section 3.2.2.1, models illustrating the fact that there seem to be temporal and casual relationships between individuals factors impacting on Strategy Execution are presented. In Section 3.2.2.2, contributions providing advise on addressing SE complexities are presented.

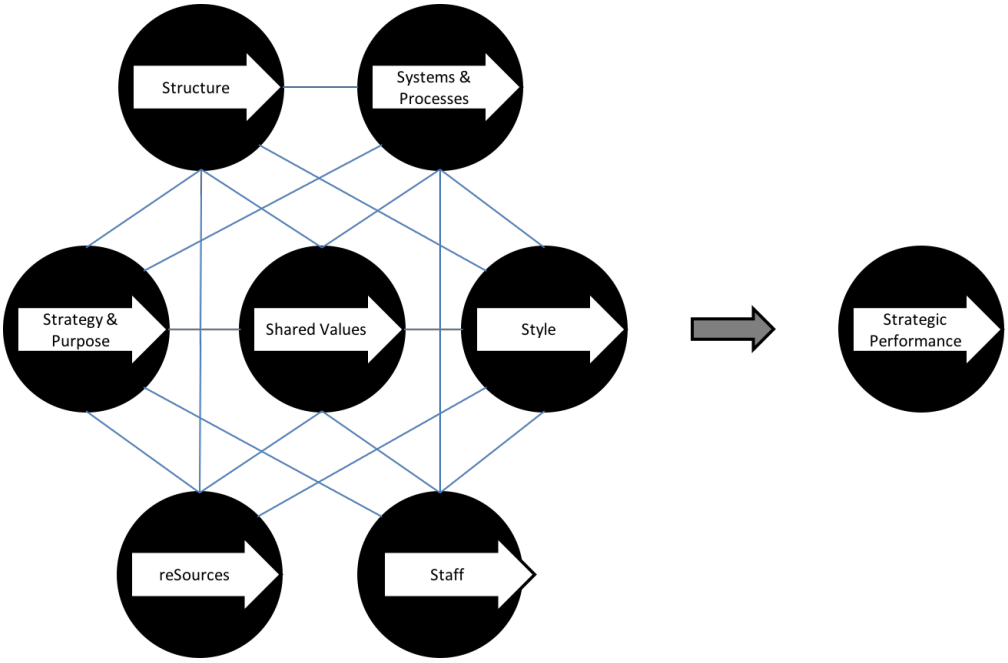
3.2.2.1 SE Models and Frameworks

Higgins (2005), developed a cross functional model based on the McKinsey 7 S model first developed by Peters & Waterman (1982). The model is depicted in Figure 3.3. The model consist of two parts:

- The Seven Contextual Ss; and
- Strategic Performance.

The seven contextual Ss must all be aligned to ensure optimal strategic performance. If there is good alignment among these factors managers will be enabled to monitor,

Figure 3.3: The 8S model for Strategy Execution



Reproduced from Higgins (2005).

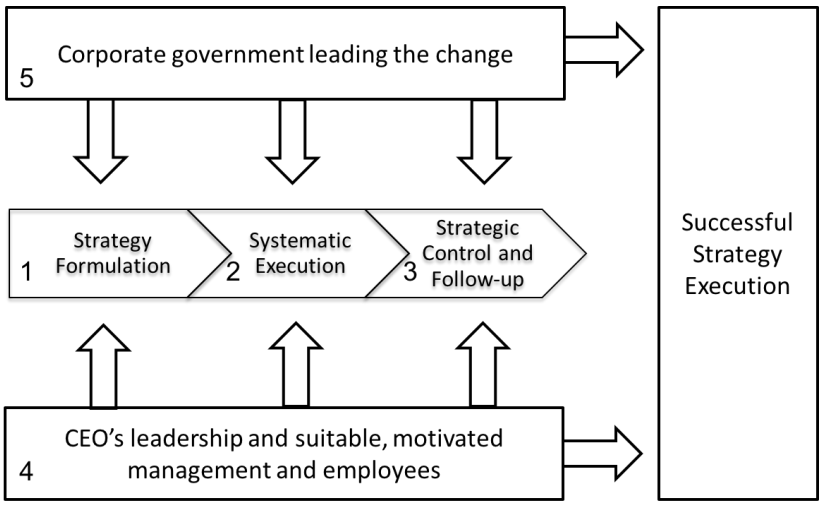
assess and enact cross functional execution of strategies. The non-alignment of these factors will result in sub-optimal Strategy Execution.

In their study of Strategy Execution, Brenes *et al.* (2008) identifies five key dimensions of successful SE. Their framework is arranged in a value chain model and depicted in Figure 3.4. They are of the opinion that the systematic development of each one of these five dimensions will give an organization a better chance of successfully execution strategy.

The three first dimensions are a sequence of interdependent actions. The completion of these action assist the organization to move from strategy formulation to performance and feedback. These actions are however completed within the constraints of dimensions four and five. Dimension four refers to the role played by the company managers, including the CEO, management, and employees (the executors as discussed in Section 3.2.2.1). Dimension five refers to those setting the firm's long-term course, that is, corporate government.

As indicated above Eisenstat & Beer (2000) identified six silent killers of Strategy Implementation which are rarely publicly acknowledged or addressed. The interaction between the six killers are illustrated in Figure 3.5. In addition to the identification of the six barriers Eisenstat & Beer (2000) also importantly illustrate how these barriers

Figure 3.4: Brenes model for successful implementation of business strategy



Reproduced from Brenes et al. (2008).

often interact, creating a vicious cycle from which it is difficult to escape. In order to illustrate the interaction the authors grouped the killers into three categories:

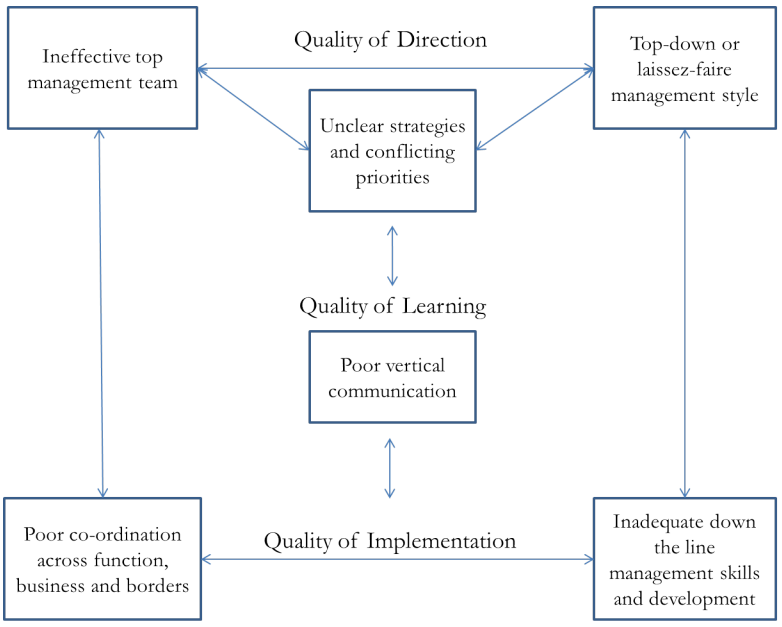
- Quality of direction;
- Qaulity of learning; and
- Quality of implementation.

Despite the fact that Brenes *et al.* (2008) make reference to five as opposed to six contextual factors identified by Eisenstat & Beer (2000) and seven factors identified by Higgins (2005), the models developed by these authors are in principle very similar. They are relatively easy to understand but do not in any way explain the exact nature and extent of the illustrated relationships between contextual factors. The model presented by Eisenstat & Beer (2000), is useful especially in its use of the cholesterol analogy and the recommendations made regarding Organizational Fitness Profiling (OFP).

Although Eisenstat & Beer (2000) suggest that it would be possible to detect the silent killers of Strategy Execution through OFP the model presented by them still does not go beyond the identification of symptoms. These symptoms are all treated as if they have the same relative importance and no mention is made of the impact these symptoms might have within a particular context. These shortcomings will be address in more detail in Chapter 6.

In the next section contributions providing advise on addressing SE complexities are presented.

Figure 3.5: Interaction between the six strategy killers



Reproduced from Eisenstat & Beer (2000).

3.2.2.2 Models providing advice on addressing SE complexities

The first is a framework developed by Noble (1999a). His framework is organized around four major Strategy Implementation stages and five mangerial levers. His framework is illustrated in Table 3.8.

Table 3.8: Noble's Strategy Implementation framework

Levers	**Pre-Implementation**	**Organizing the implementation effort**	**Managing the implementation process**	**Maximizing cross functional performance**
Goals	Ensure that all managers are aware of the strategic goals of the firm	Introduce goals of the strategy being implemented, incl. fit within firms broader strategic vision	Maintain the flexibility to adapt goals based on environmental changes	Develop and focus on common goals to encourage cross-functional cohesiveness

Levers	Pre-Implementation	Organizing the implementation effort	Managing the implementation process	Maximizing cross functional performance
Organizational structure	Ensure that functional areas have the slack resources needed to be able to contribute to an implementation effort	Establish a formal implementation unit and ensure its visibility throughout the firm	Ensure equal representation by all affected functional areas	Temporarily suspend key implementation team members normal
Leadership	Develop employees knowledge and appreciation of multiple functional areas	Establish a champion who has both official cross-functional authority and general respect in the firm	Ensure that leaders show equal attention to all functional-level concerns	Balance visible and charismatic leadership with a maintenance of autonomy for functional-level implementation efforts
Communications	Maintain regular cross-functional communications to foster understanding and appreciation	Discuss and resolve implementation details early in the process	Update implementation team frequently on progress and changes in objectives	Communicate implementation progress across the entire organization to foster buy-in
Incentives	Reward the development of cross-functional skills	Develop time and performance-based incentives for implementation team while lessening traditional functional incentives	Adjust incentives as strategy and environmental conditions change during implementation	Establish visible and consistent cross-functioanal rewards for successful implementation efforts

Adapted from Noble (1999a).

The framework is useful because Noble (1999a), in addition to the identification of managerial levers (also defined by a number of other contributors see Section 3.2.2.1), also illustrates that the SI process consist of a number of distinct phases. Prior to the contribution made by Noble (1999a), most other contributors treated the SI process as a single step or phase that had to be completed after strategy was formulated.

No judgment is made regarding the appropriateness of Noble's distinct implementation phases, his contribution lies in the fact that the complexity of the SI process is acknowledge and in the provision of the practical advise, to address possible stumbling blocks during each implementation phase. Despite the fact that the implementation advise is generic in nature it is useful and should be considered by practitioners as a valuable

guideline during the Strategy Implementation planning process.

Sull (2007) is in the final instance of the opinion that failure often has its roots in the view academics and practitioners have of organizational strategy *per se*. In his view strategy is, despite the fact that organizations find themselves within a continuously changing environment, still viewed as a linear process. This process typically involves executive managers who drafts a detailed road map to a destination and thereafter middle managers develop a detailed implementation plan. This linear process is however fundamentally flawed for two reasons:

1. The formulation of strategy is treated as the first step in a project. The strategy is thus developed as a prefabricated plan at the beginning of the process, when least is known about how the process will evolve. It is often impossible to anticipate at this point what the responses of competitors, regulators or customers might be

2. Leaders often have to escalate their commitment to a flawed plan as evidence mounts that the grand plan might be flawed. The escalation of commitment is often the result of the fact that the credibility of managers and leaders come under fire if strategies fail. When things go wrong managers and leaders find it difficult to accept that a mistakes might have been made during the conceptualization of the the grand plan – instead more resources are often committed to project or problems are attributed to so called unexpected setbacks[1]; and

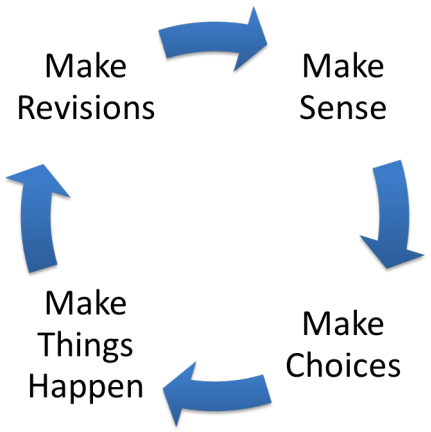
3. The importance of timing is often ignored. After formulation of the strategy, there is often huge pressure on middle-management to *"get on with the job"*. Rushing to execute a flawed strategy however only ensures that the organization gets to the wrong place sooner[2]

Sull (2007) thus suggest that instead of treating strategy as a linear process strategy should be treated as an inherently iterative process – strategy should thus be treated as a loop rather than a line. In his view every strategy is thus work in progress that will evolve in the light of interaction between the organization and the dynamic environment in which it operates. The strategy loop is illustrated in Figure 3.6 and consist of four major steps: making sense of the situation, making choices on what to do (and what not to do), making those things happen and making revisions based on new information.

[1]The US involvement in Vietnam is a classical example of the escalation of commitment to a flawed strategy

[2]Chopping down the trees in the wrong forest is an analogy used by Covey (1989) and often referred to in this regard.

Figure 3.6: The Iterative Strategy Loop



Adapted from Sull (2007).

Sull (2007) also recommends various discussion leaders should have during the Strategy Execution process. The agenda for these discussion are presented in Table 3.9. He is of the opinion that managers who master these discussions will be able to identify emerging opportunities and to more effectively make timeous adjustments to the strategic plan. This will ultimately lead to more successfull execution.

Table 3.9: Discussion through the strategy loop

	Make Sense	**Make Choices**	**Make Things Happens**	**Make Revisions**
Objective	Develop a shared mental model of a situation	Agree on clear priorities to guide action and resource allocation	Ensure that people make good promises and deliver	Sense anomalies and revise key assumptions
Appropriate Tone	Open inquiry	respectful argumentation	Supportive discipline	Dispassionate analysis
Information Support	Shared dashboard of real–time, granular data	Ongoing monitoring of "hard" and "soft" priorities	Monitor performance against promises	Variance reporting of key variables to spot anomalies
Required Leadership Traits	• Coup doeil; • Curiosity ; • Empathy to see other points of view.	• Decisive; • Enterprise perspective; • Credibility to make the call.	• Trustworthy; • Flexible tenacity; • Ability to inspire others.	• Intellectual humility; • Respect for other viewpoints; • Sensitivity to anomalies.

	Make Sense	Make Choices	Make Things Happens	Make Revisions
Pitfalls	• Advocating pre-existing positions; • Anchoring too quickly on one viewpoint; • Bias for premature action.	• Superficial agreement; • Politicized prioritization; • Priority proliferation; • Searching for complete consensus.	• Private promises; • Passive agreement; • Meaningless yes; • Implicit agreements; • What without why.	• Blame game; • Escalating commitment to failed course of action; • Cognitive biases toward confirming evidence.
Helpful Tips ;	• Question assumptions; • Interact frequently.	• Explicit prioritization; and • Simple rules to prioritize.	• Publicly monitor promises; and • Link promises to priorities.	• Build in regular reviews; and • Bring in external reviewers.
Killer Questions	• What fresh data would convince us that our assessment is wrong?	• What will we stop doing?	• What did you promise to do? • What have you done? • What is hindering you? • What did we expect to happen versus what really happened?	• Why the difference? • What should we change?

Reproduced from Sull (2007).

Both these contributions provide valuable insights and recommendations. Within the context of the contemporary organization and the need to develop agile strategies the model presented by Sull (2007), is particularly useful. The application of the principles recommended by both these studies should indeed assist organizations during the Strategy Execution process.

It is again tempting to present yet another model illustrating the potential causal relationships between various individual factors that influence the process. This is however not the focus of this study and it is doubtful whether the presentation of these factors

in which ever format will in itself lead to the early detection and prevention of Strategy Execution failure. The insights gained through the analysis of these contribution will however be used during the development of the model for the early detection and prevention of PAM Strategy Execution Failure in Chapter 6.

3.3 SEBOK limitations, shortcomings and opportunities

In Chapter 3 the most important contributions regarding the complexities involved in the Strategy Execution process was evaluated. It became clear that up to the start of the contemporary strategy period the overwhelming majority of strategy research focussed on the planning process or on the content of the strategy being formulated. As illustrated in Section 3.2.2.2 Sull (2007) is of the opinion that many organizations still treat the formulation and execution of strategy as separate steps.

Despite the fact that a number of academics and researchers have heeded the calls for research that explores the field of Strategy Execution in more detail, Sull *et al.* (2015) is still of the contention that contributions on strategy formulation is far outnumber those on execution.

After analyzing the SEBOK it became clear that there is not a universally accepted definition for . In Section 3.1 the various definitions that do exist was evaluated and the section is concluded with the presentation of a definition that would be used as reference point for the purpose of this study.

The analysis of the SEBOK furthermore revealed that there are mainly two streams of research. The first stream focuses on the identification of individual factors that influence Strategy Execution. The second stream focus on the presentation of models to illustrate how individual factors interrelate to form a Strategy Execution environment.

In Section 3.2 the most important contributions from both these streams were presented and evaluated. The following conclusions were drawn after the analysis of the existing SEBOK:

- Executors or managers receive the most attention in the contributions made. The role of non-management during the execution process is however often ignored;
- The importance of communication during the process permeates all studies and its role can thus not be underestimated. Communication helps building understanding and acceptance. Although several researchers point out that communication is an important factor, very few studies however provide an in-depth analyses about how exactly communication influences the process;
- There is often disagreement between researchers on the exact meaning and content of concepts used. This is most probably a reflection of the relative immaturity of

the field of study. For this reason was defined specifically in Section 3.1.

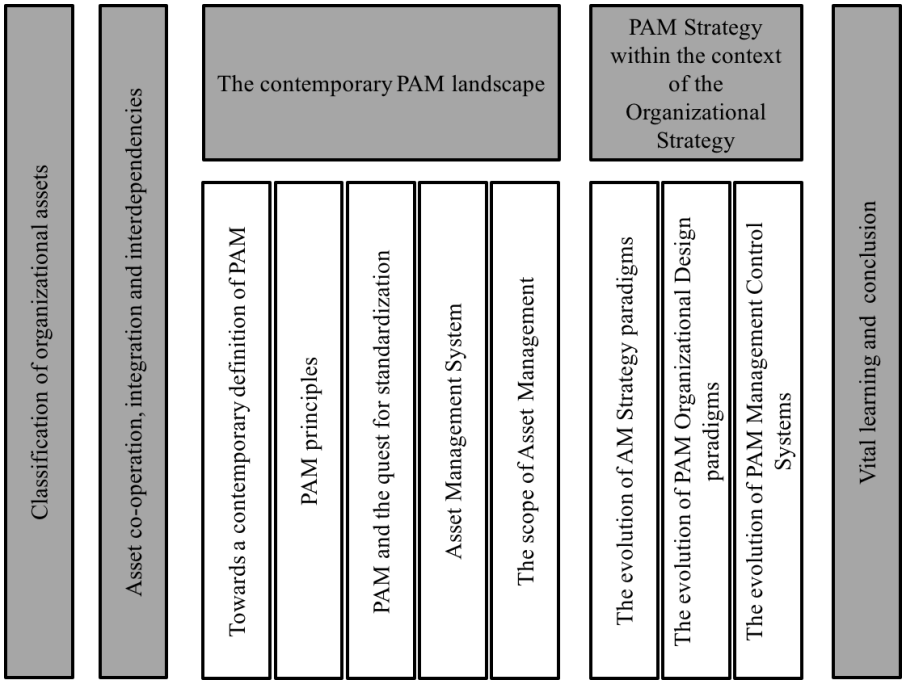
- The process is complex and influenced by a multitude of factors spanning various disciplines including Finance, Project Manangement, Phycology, Sociology and Economics. The presentation of simplistic remedies to solve problems is thus unrealistic;
- There is a clear trend towards frameworks and model-based approaches to Strategy Execution. The contributions made by the authors of these models and frameworks are valued and accepted. The models are relatively easy to understand but do not in any way explain the exact nature and extent of the illustrated relationships between contextual factors. These factors identified in these models are also treated as if they have the same relative importance and no mention is made of the varying impact these factor might have within a particular context.
- None of the contributions within the SEBOK provides a mechanism that organizations can use to ensure the early detection of possible Strategy Execution failure.

In the next chapter PAM strategy will be evaluated and contextualized before PAM Strategy Execution will be explored and analyzed in Chapter 5.

Chapter 4

Physical Asset Management Strategy

Figure 4.1: Chapter 4 Outline



Physical Asset (PA)s has always been regarded as an important source of value, and PAM been done for many years. The scope of its management has however according to Woodhouse (1997) undergone a significant shift in recent years. Amadi-Echendu (2004) refers to the *"Paradigm shift from maintenance to Physical Asset Management (PAM)"*. Amadi-Echendu (2004) is of the opinion that is since the turn of the century academics

and practitioners illustrated growing interest in generalizing PAM. The generalization of PAM requires a far more strategic approach and highlights the importance of a multidisciplinary skill set, cross functionality, and targets organizational synergies. The prevalent threats, from traditional paradigms such as silo mentality and communication deficiency shifted towards an integrated view that especially emphasizes the strategic and human dimension.

It is assumed that readers of this text would be familiar with general PAM concepts and the content of contemporary PAM discourse. The objective of this chapter is thus not to provide a detailed overview of general PAM developments and practices, but to evaluate developments in the formulation of PAM strategy over the past three decades. For the purpose of academic prudence a brief overview of contemporary PAM practices and tactics are however provided in section one of this chapter. It is however important to note that many of the topics discussed in part one of this chapter has an impact on, or is impacted by the strategy. Many of the topics introduced in the next section are, depending on its relevance, referred to again, in more or less detail, in Section 4.4.

This chapter thus has the following major outcomes:

- Present an organizational asset classification framework and present a model illustrating how these assets work together to create organizational value;
- Provide a brief overview of recent developments within the PAM landscape;
- Evaluate PAM strategy developments over the past 100 years within the context of the organizational strategy and within the context of contemporary strategy discourse.

In the next section an organizational asset classification framework is presented. The section is concluded with the presentation of models illustrating the possible interdependence of various asset classes during the value creation process.

4.1 Classification of organizational assets

Historically, the financial sector championed the organizational use of the term asset (Michaud & Michaud (2008), Ghosh (2011)). The "efficient markets hypothesis"[1] defined by Fama (1970) and later reviewed by Fama (1998) is a classical example hereof. The hypotheses states that:

> *"...a firm's stock price, or firm valuation, always reflects all information currently available to investors and potential investors..."*

[1]The hypothesis still forms a fundamental theoretical underpinning for understanding firm valuations and is a cornerstone of contemporary finance theory.

This implies that the stock price (market value) of a firm reflects investor perceptions of the current and future earnings potential of all its assets, both tangible, intangible and human. ISO 55000[1] (ISO (2014)) defines an asset as follows:

> *"... an asset is an item, thing or entity that has potential or actual value to an organization...*

In order to evaluate the potential or actual value of an asset it is however important to be able to classify organizational assets and to understand the interdependence of these assets. The classification of organizational assets proofs to be more difficult than anticipated and traditional balance sheets often provides only a partial and distorted view of the firms total assets. Various scholars have attempted to develop asset classification models. The purpose of this section is not to evaluate or make any value judgements regarding these contributions. The framework presented at the end is this section was distilled after analysis and evaluation of these contributors. The model is developed to provide a framework for the purpose of this study. Specific reference will be made to the following contributions:

- The contribution by Grant (2010);
- The model developed in PAS 55 (PAS-55 (2004); and
- The contributions by Marr *et al.* (2004)

In an attempt to classify various organizational assets Grant (2010) developed an asset classification model. This model is discussed in detail in Section 2.2.2.5. The model is included in this section for easy reference (see Figure 4.2).

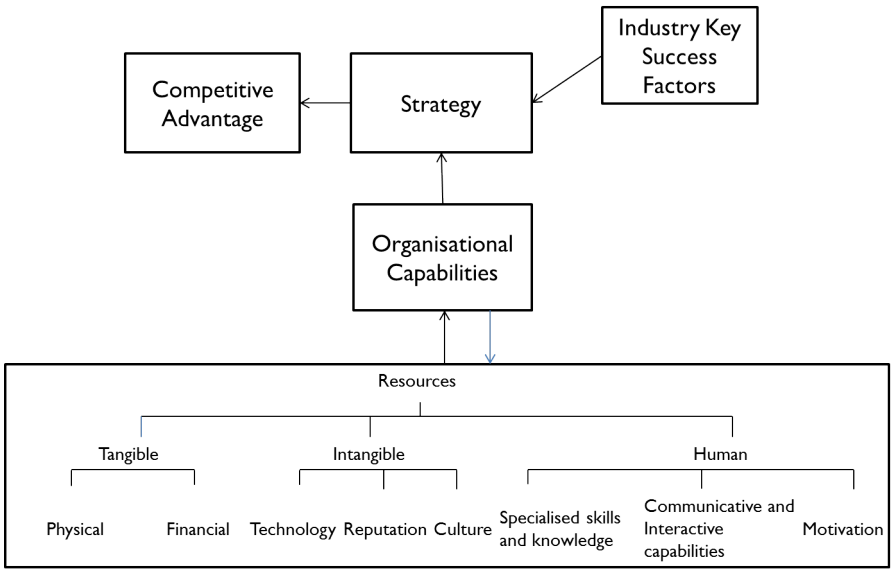
PAS-55 (2004)[2] also developed a classification model in an attempt to contextualize physical assets. In their model five broad asset categories that have to be managed integrally are identified. These are:

- Financial Assets;
- Physical Assets;
- Human Assets;
- Information Assets;

[1]ISO 55000 is the first set of International Standards for asset management and was accepted by the International Organization for Standardization (ISO) in 2014. The specification is discussed in more detail in Section 4.3.3.2.

[2]The first attempt to define a PAM industry standard framework was done by the Institute for Asset Management, together with the British Standards organization and other collaborating organizations the PAS-55 (2004) was defined in 2004 a as standard specification for the optimized management of physical assets and infrastructure. The standard received a review and update in 2008 (BSI (2008)).

Figure 4.2: Grant's asset classification model



Adopted from Grant (2010).

- Intangible Assets.

Figure 4.3 illustrates the relationship between the five broad asset classes. These asset classes are however described in far more detail in Section 4.1.1.

In addition to the asset classes identified by Grant (2010) and PAS-55 (2004), Marr *et al.* (2004) also defines Relationships and Practices, and Routines as specific asset classes.

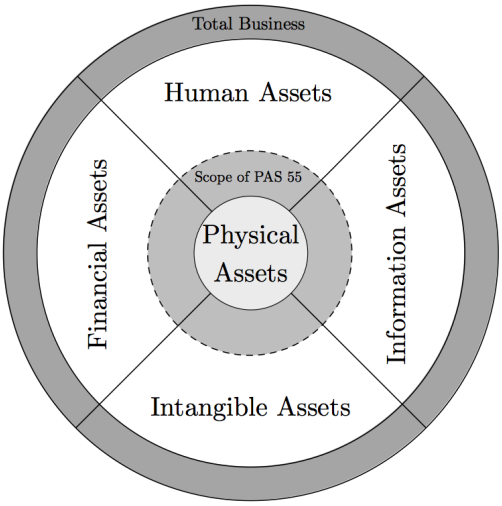
The classification model presented in Figure 4.4 is a combination of the work done by Grant (2010), Marr *et al.* (2004) and PAS-55 (2004). The model developed by Grant and presented in Figure 4.2 was used as the basis in the development of this model. The various asset classes are discussed in more detail in Section 4.1.1.

4.1.1 Integrated organizational asset classification framework

It should be noted that it is not the aim to develop a totally comprehensive organizational asset taxonomy, the classification framework presented here is merely developed to provide a reference point for the purpose of this study.

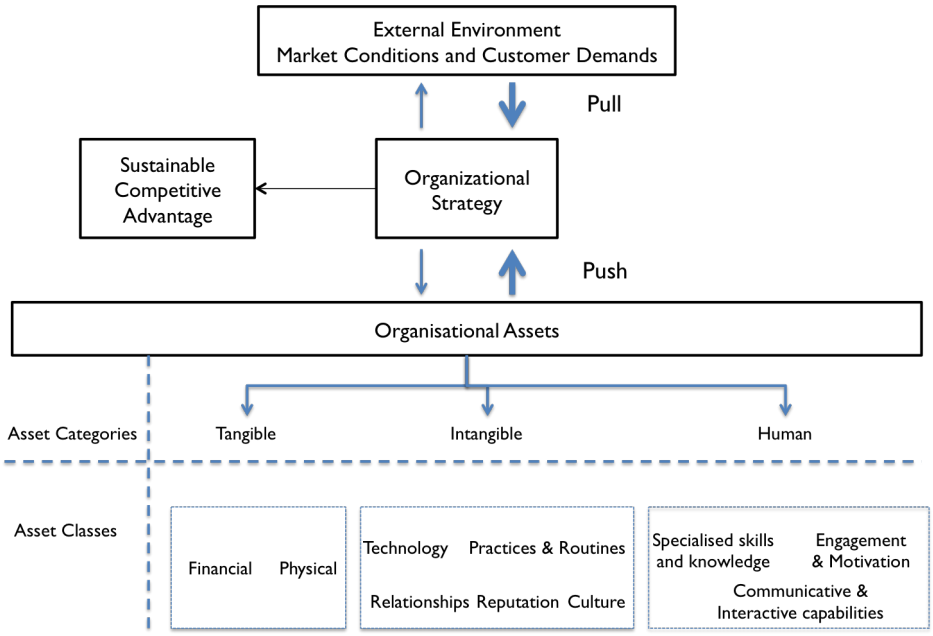
It should be clear that the model acknowledges that organizational strategy is influenced by both internal and external factors. The strategy is often "pulled" by the external environment (market conditions and customer demands) and "pushed" from within ("re-

Figure 4.3: Asset Classes



Reproduced from PAS-55 (2004)

Figure 4.4: Organizational asset framework



Adapted from Grant (2010)

source based view of the firm")[1]. Within the context of the contemporary organization sustainable competitive advantage is only possible if the organization is agile and able to continuously adapt to changing circumstances.

The asset classes as identified by Grant (2010), PAS-55 (2004) and Marr *et al.* (2004) are grouped into three broad asset categories:

- Tangible assets;
- Intangible assets; and
- Human assets.

Each one of these categories are briefly described below.

Tangible assets – are the easiest to identify and evaluate. These assets typically include financial resources and Physical Assets. They are noted in the firms financial statements, but due to various reporting principles such as the Generally Accepted Accounting Principles (GAAP), that determine the rate at which Physical Assets can for example be devalued for tax purposes, balance sheets often obscure the true strategic value of this asset class (Grant (2010)).

Intangible assets – remains largely invisible in terms of the organizations financial statements. On most balance sheets intangible assets are typically referred to as *"goodwill"* and capitalized Research and Development (R&D). In many instances the true value of a company may thus be both invisible and non–obvious.

Human Assets – In economist's terminology the productive capability of human beings are referred to as *"Human Capital (HC)"*. Identifying and appraising the stock of HC in an organization is however complex. The assessment of skills, qualifications and experience is relatively easy but these are only indicators of potential and thus not really predict true performance. The performance prediction problem is further exacerbated by the fact that people typically work in groups or in teams. In the same way a group of high potential sports men and women may produce sub–standard results if the team dynamics are not conducive, high potential individuals within the work context might produce sub-standard results because of non-optimal team dynamics (Barney (1991)).

Progressive organization are thus increasingly recognizing that in the evaluation and development of HC inventories it is not just individuals' expertise and knowledge that is important but the firms ability to ensure that these resources are brought together to function as an integrated whole (Grant (2010)).

[1] Barney (1991), described the "resource based view of the firm". His ideas are discussed in more detail in Section 2.2.2.5.

Each one of the identified asset classes are discussed in more detail in the following section:

- **Asset Category: Tangible Assets**
  - **Asset Class: Financial Assets** The overriding reason for the existences of most business organizations is to achieve a more than acceptable return on financial assets (read money) invested, for the investors and other key stakeholders in the business. The return is typically assessed in the context of the particular risk associated with the business, as it is a fundamental economic principle that increased risk must be compensated for with higher levels of financial returns. Money is thus in most instances both the means and the end. Shareholders invest Financial Assets in projects that require the acquisition of other asset classes. The sole reason for investing is however to ensure sustainable competitive advantage. This process is key to increasing shareholder value, which is the basic premise of modern market driven economies Bender (2013).
  - **Asset Class: Physical Asset (PA)s** In very generic terms, PAs imply those units and entities *"hardware"* that bear some form of economical value to an organization and typically include buildings, office–ware, vehicles and other automobile units, and production–, manufacturing–, process facilities or plants (Hodges (1996), Tsang (2009) and Lai (2013)).

    PAs are regarded as important strategic nodes of business value creation. In addition to the dynamic contribution PAs make (or should be making) during the value creation process, PAs also has inherent economical value in cases where they are re-sold (Amadi-Echendu *et al.* (2010)).

    The characteristics of the PAM process will be discussed in more detail in Section 4.3

- **Asset Category: Intangible Assets**
  - **Asset Class: Technology** Grant (2010), identifies Technology as an important asset class within Intangible Asset category. Technology includes ownership of Intellectual Property (IP), patents, copyrights and trade secrets. Hall (1989) defines IP as:

    > *"...those assets to which the organization has property rights, such as patents, trademarks, registered designs, and copyrights, which all afford legal protection to the owners of certain classes of intellectual assets..."*.

    In a study done by Grindley & Teece (1997), within the semi-conductor industry they make specific reference to the increasing importance of patentable intellectual property. They claim that IP is one of the most critical competitive

advantages that high-tech organizations has. May (2013) contextualize the importance of IP within the context of the global Political Economy. The ongoing legal battle between Apple and Samsung regarding the design of smartphones and tablet computers is a classical example of the importance of technology as a source of intangible competitive advantage.

- **Asset Class: Reputation and Brand Value** Keller & Lehmann (2003) are of the opinion that organizational reputation and brand is one the most valuable intangible assets organizations have. Brand Value is according to these theorists the result of a chain of events that are influenced by a number of stakeholders and variables during the total value creation process. Reputation and brand are typically attached to both the company or the products produced by the company.
- **Asset Classs: Relationships** Relationships as a class of Intangible assets refers to all relationship within the organization as well between the organization and the external environment. These relationships can include formal as well as non-formalized relationships. In this regard Itami & Roehl (1987) make specific reference to the importance of information or knowledge exchange between organizations and their external environment. Information flows from the firm to the external environment include corporate reputation, brand image, corporate image, and influence over the distribution channel and its suppliers.
- **Asset Class: Culture Assets** The subject of corporate culture has over the years generated a flood of articles, with many contributors providing definitions and speculating about the true value of organizational culture as a driver of organizational performance. Itami & Roehl (1987) for example are of the opinion that corporate culture gives each person in an organization a common and distinctive method for transmitting and processing information. Culture defines a common way of seeing things, sets the decision-making pattern, and establishes the value system.

  Gordon & DiTomaso (1992) were some of the first theorists to conduct an empirical study to establish the real relationship between culture and organizational performance. They conducted a study within eleven American companies and came to the conclusion that there was indeed (especially in terms of short term performance) a positive relationship between culture and performance. These views are confirmed by Zheng *et al.* (2010), and Hartnell *et al.* (2011). In all these studies the focus fell on the managerial values and beliefs embedded within the respective organizational cultures. Culture as an asset includes aspects such as corporate culture, organizational values, and management philosophies. Culture as an assets provide employees with a shared framework. A framework that encourages individuals to operate both as an autonomous entity and as a team in order to achieve the companys objectives.
- **Asset Class: Practices and Routines** Dosi *et al.* (2000) observe that

shared knowledge in organizations is often expressed in routines. For this reason even skilled operators and managers often first need an induction period to understand the way in which they should apply their knowledge and skills within a given environment.

Itami & Roehl (1987) identify the important role organizational routines has in the management and transmission of information. For this reason they regard routines an as a valuable intangible asset. Practices and routines include according to them internal practices, virtual networks and routines. These practices and routines are both formal and informal and thus includes both explicit and tacit knowledge as defined by Nonaka *et al.* (2006). Formalized routines include process manuals and Standard Operating Procedures (SOP's) providing codified procedures and rules. Sajdak *et al.* (2013) explain the critical importance of both defining and following SOP's within the context of clinical trials. Informal routines would be tacit rules of behaviour or workflows. Practices and routines determine how processes are being handled and how work flows through the organization.

- **Asset Category: Human Assets**
  - **Asset Class: Human Assets** One of the first theorists to acknowledge the important and distinct contribution of Human Assets was the economist Becker (1964). Schultz & Schultz (1982) and Schultz (1993) concur and use the phrase human capital defining a core asset of an organization. Hall (1992) emphasizes skills and know-how as important assets. Human assets, therefore include employees skills, competences, commitment, motivation and loyalty. Some of the key components are know-how, technical expertise, and problem solving capability, creativity, education, and attitude. Ployhart & Moliterno (2011) define human capital as a

    > *"...unit-level resource that is created from the emergence of individuals Knowledge, Skills, Abilities and Other characteristics (KSAOs)."*

    Organizations thus possess a pool of human capital made up of the individuals with unique KSAO endowments.

4.2 Asset co-operation, integration and interdependencies

Penrose (1959) already in 1959, argued that organizational assets exist as a bundle, while others including (Dierickx & Cool (1989) and Lippman & Rumelt (2003) are of the opinion that these resource bundles impact performance with causal ambiguity and that it is difficult to identify how individual assets contribute to success without taking the interdependencies with other assets into account.

Resources are thus not normally productive on their own. Leadership teams need to actively intervene to ensure the optimal cooperation and integration of resource within the organization. The best performing organizations are normally those that understand their unique abilities the best. Selznick (1984) refers in this regard to the organizations *"distinctive competence"* (see Section 2.2.2.6) . Distinctive competence describes those things that the organization does particulary well in relation to its competitors. Prahalad & Hamel (1993) coined the term *"core competence"* to distinguish those capabilities that are more important to a firms success from those that are less important.

Both these terms focus the attention on the issue of competitive advantage. The importance is thus not the organizational capabilities *per se* but the capabilities relative to that of the competition.

Porter & Millar (1985) developed a classification (the *"Porter Value Chain"*) to assist organizations to distinguish between primary and secondary activities.[1]

In an attempt to map these interdependencies further, Kaplan & Norton (2000) introduced Strategy Maps (see Figure: 4.5) as tools to chart how intangible assets are converted into tangible outcomes (see detailed discussion in Section 2.4.6.4). These authors maintain that Strategy Maps,

> *"...give employees a clear line of sight into how their jobs are linked to the overall objective of the organization, enabling them to work in a coordinated, collaborative fashion toward the companys desired goals..."*

They further claim that Strategy Maps provide a visual representation of the dynamics between organizational performance drivers and assets.

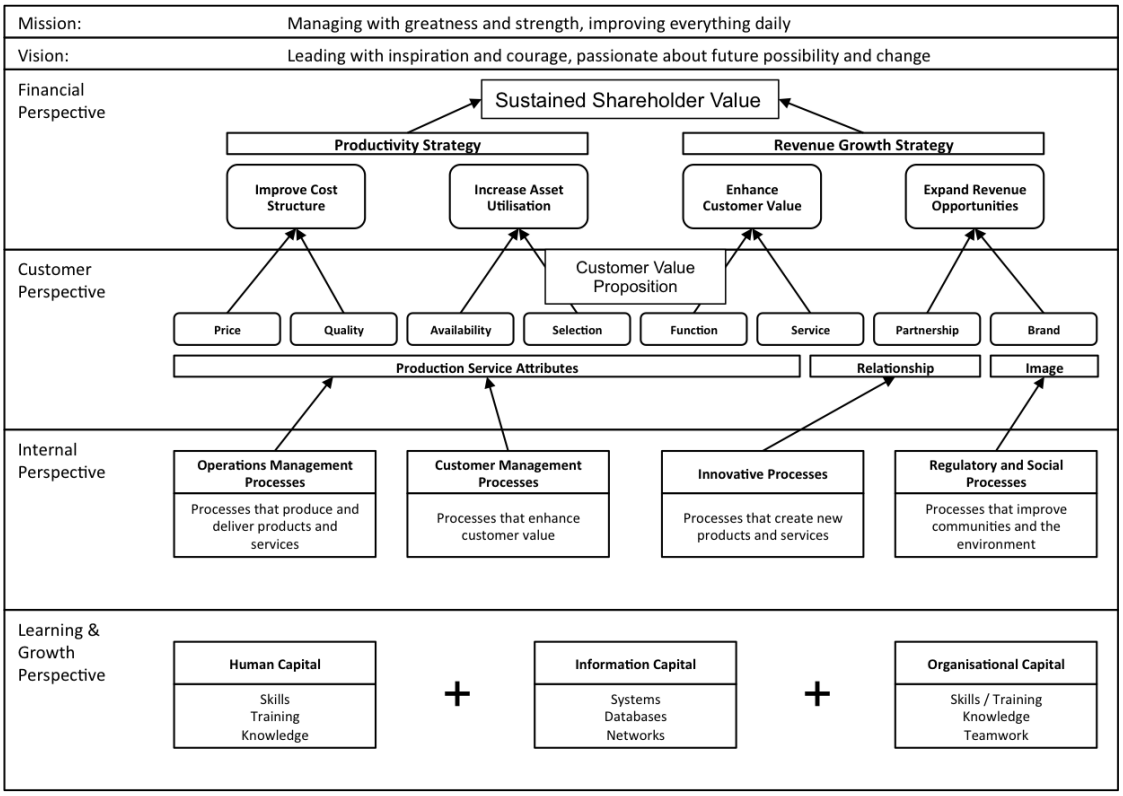
Based on the four perspectives of the Balanced Scorecard (BSC), Kaplan & Norton (2000) Strategy Maps thus illustrate how an organization will convert its initiatives and resources – including intangible assets such as corporate culture and employee knowledge – into tangible outcomes. Figure 4.5 shows the template for Strategy Maps with its four perspectives – financial, customer, internal processes, and learning and growth.

Marr *et al.* (2004) contend that the efficient management of organizational assets is impossible without understanding the interrelationships and interdependencies between these assets. Strategy Maps are according to them useful for mapping the direct dependencies between organizational assets, they are however sceptical about the effectiveness of Strategy Maps to also map the indirect dependencies. They suggest that these indirect dependencies should be mapped through the development of so–called *Value Creation Maps (VCM)*s.[2]. These principles are, amongst others applied in the development of the model for the early detection and prevention of Physical Asset Management Strategy

[1]The Porter Value Chain is discussed in detail in Section 2.2.2.6 and the discussion will not be repeated in this section.

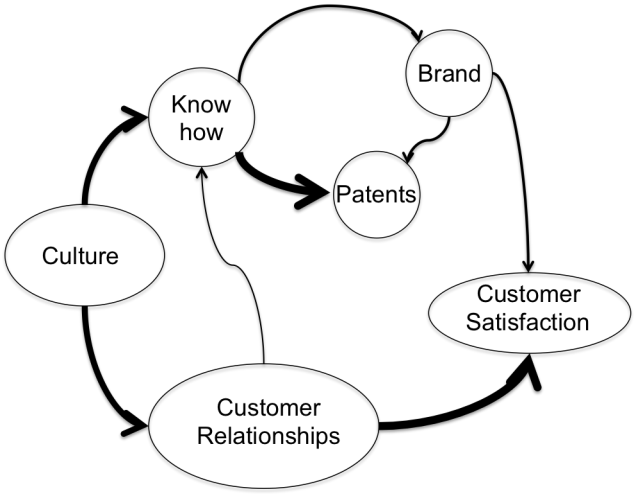
[2]A detailed discussion of the design principles of a value creation map falls outside the scope of this section.

Figure 4.5: Strategy Map



Adapted from Kaplan & Norton (2000).

Figure 4.6: Value Creation Map



Adapted from Marr et al. (2004).

Execution Failure. A typical example of a Customer Satisfaction VCM is illustrated in Figure 4.6

With a full understanding of the fact that different asset types and classes do not perform in isolation the focus in the next section of this chapter will however fall on a more detailed contextualization of Physical Assets and evolving management strategies and protocols in the field of PAM.

4.3 The contemporary PAM landscape

The PAM landscape has undergone a number of changes in recent years and contemporary contributors acknowledge the fact that effective PAM requires an integrated approach that joins bordering disciplines[1]. Within the changing landscape the PAM focus has also according to The Institute of Asset Management (IAM (2011)), shifted from *"doing things to assets"* to *"using assets to deliver value and achieve the organizations explicit purposes"*.

The largest challenge facing operating and production organizations has, since the turn of the century been the necessity to maintain, and increase, operational effectiveness, revenue and customer satisfaction. Organizations need to achievement of these objectives, while simultaneously reducing capital, operating and support costs (Mitchell

[1]See a detailed evaluation of traditional approaches to PAM in Woodhouse (1997), Amadi-Echendu (2004), Amadi-Echendu *et al.* (2010) and Hastings (2010)

et al. (2007)). In addition hereto organizations are under continuous pressure to ensure high levels of equipment availability, reliability and maintainability. Schuman & Brent (2005) contend that the effective management of physical assets thus plays an increasingly important role in optimizing business profitability.

Davis (2007) is of the opinion that a cumulative recognition (among AM practitioners and theorists) for the need for optimizing the mix of cost, risk and performance over the assets entire life-cycle, and to do so in a governable and sustainable manner, was the catalyst for the changes in PAM landscape.

In this section some of the most recent developments within the field of PAM are discussed. As indicated in the introduction to this chapter it is however assumed that readers of this text would be familiar with general PAM concepts and the content of contemporary PAM discourse. The objective of this section is thus merely to provide a brief overview of recent PAM developments and practices. It was also noted that the issues relating to strategy permeates most management topics, many of the topics introduced in the next section are, depending on its relevance, referred to again, in more or less detail, in Section 4.4.

4.3.1 Towards a contemporary definition of PAM

The extensive literature review on the subject of PAM highlighted the inconsistent use of vocabulary. Terms like *"asset management"*, *"total asset management"*, *"engineering asset management"* and *"physical assist optimization"* is often used interchangeably. The inconsistent use of terminology highlights the relative immaturity of debates within the field.

For the purpose of this study reference will only be made to PAM and the section will be concluded with a contemporary definition of PAM that will be used as reference point throughout the text.

In PAS-55 (2004) AM is defined as follows:

> *"...systematic and coordinated activities and practices through which an organization optimally and sustainably manages its assets and asset systems, their associated performance, risks and expenditures over their life cycles for the purpose of achieving its organizational strategic plan..."*

ISO 55000[1] ISO (2014) provides the following definition for AM:

> *"Asset Management involves a disciplined approach which enables an organization to maximise value (or minimise liabilities) from the portfolio of assets for which it has a responsibility in delivering its strategic objectives.*

[1]See a detailed discussion on the role and contribution of the ISO 55000 standard in Section 4.3.3.2.

> *This includes determination of appropriate assets to create or acquire in the first place, how best to utilise and support them, and the adoption of optimal renewal or disposal actions, along with the ongoing management of any residual liabilities."*

The scope of Asset Management is thus far broader and quite different from mere maintenance activities, which is mainly concerned with ensuring that existing physical assets are in good operating condition.

Contemporary PAM definitions consistently recognize the need for integration. Mitchell & Carlson (2001) are regarded as pioneers in the field of PAM and characterize PAM as a strategic, integrated set op comprehensive processes to gain greatest lifetime effectiveness, utlization and return from physical assets.

4.3.2 PAM principles

ISO 55000 ISO (2014) identifies four AM principles. Despite the fact that some of these are common management principles, ISO 55000 warns that the non-adherence to these principles can result in a reduction in the value realized from the use of assets. These principles are:

- Assets exist to provide value to the organization and its stakeholders;
- Asset management transforms strategic intent into technical and financial decisions, plans and activities;
- Leadership and workplace culture are determinants of value realization; and
- Asset Management provides assurance that the assets fulfil their required function.

These principles should according to ISO (2014) form the foundation of the organizational AM policy and strategy. These principles will be evaluated in more detail in Section 4.4.

4.3.3 PAM and the quest for standardization

Despite that fact that PAM is a relatively new field of study, academics and practitioners have made huge progress in their attempts to standardize the field. The route to PAM standardization is characterized by two major milestones:

- The publication of the PAS 55 (PAS-55 (2004)) specification; and
- The publication of ISO 55000 (ISO (2014)) as the first set of International Standards for Asset Management.

In the next two sections these two milestones are briefly discussed.

4.3.3.1 PAS 55

It was indicated is Section 4.1 that the first attempt to define a PAM industry standard framework was done by the Institute for Asset Management, together with the British Standards organization and other collaborating organizations. In 2004, PAS 55 was defined by these institutions as a standard specification for the optimized management of physical assets and infrastructure .

Van den Honert *et al.* (2013) are of the opinion that the Plan-Do-Check-Act (PDCA) cycle, developed by Dr W. Edwards Deming in 1950 as a quality control mechanism, forms the basis of PAS 55 framework. PAS 55 has three key elements:

- It places the responsibility for Asset Management (AM) firmly in the hands of executive management;
- It is broad in reach, driving a cross-functional approach; and
- It addresses the key issues of risk, whole-life costing, and knowledge management, together with sustainability and accountability.

PAS 55 was published and subdivided into two parts: PAS 55–1 is the specification for the optimized management of Physical Assets and provides recommendations for establishing, documenting, implementing, maintaining and continually improving an Asset Management System (AMS). PAS 55–2 contains the guidelines for the implementation of PAS 55–1. These two sections are hereafter referred to as PAS 55 as a specification, rather than as two separate publications.

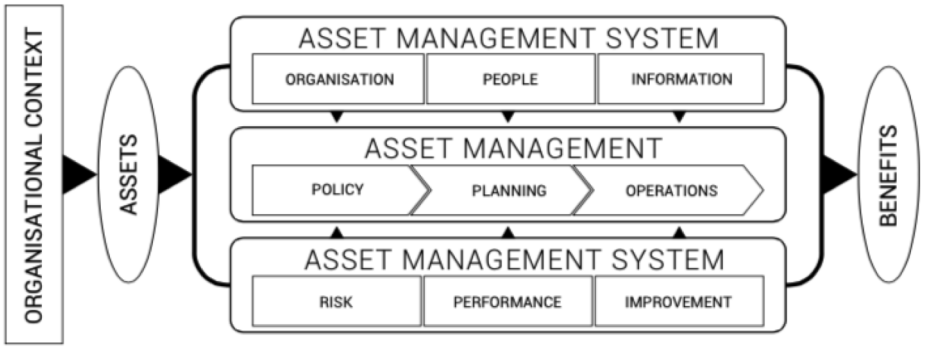
PAS 55 provides three main categories of organizations which stand to benefit most from PAS 55. These categories are shown in Table 4.1. These organizations are frequently referred to as asset-centric organizations.

Table 4.1: PAS 55 Categories of organizations

Asset Class	**Description**
Category 1	Any Physical Asset intensive business, where significant expenditure, resources, performance dependency and/or risks are associated with the management of physical assets.
Category 2	Any organization that has, or intends to manage or invest in, a significant portfolio of physical assets, or where the performance of asset systems and the management of PAs are central to the effective achievement of business objectives.
Category 3	Organizations where there is a business or public accountability requirement to demonstrate best value in the safe management of PAs and provision of associated services.

Reproduced PAS-55 (2004)

Figure 4.7: Key concepts covered in ISO 55000



Reproduced from ISO (2014)

4.3.3.2 ISO 55000

PAS 55 was accepted by the International Standards Organization (ISO) as the basis for the development of the new ISO 55000 series of international standards that was accepted by the ISO early in 2014 as the first set of International Standards for Asset Management. The ISO 55000 standards consist of the following components:

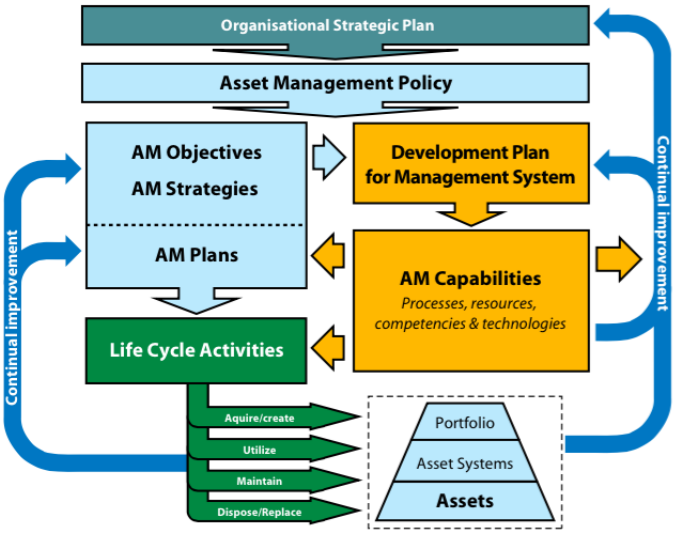
- ISO 55000 specifies the overview, concepts and terminology in Asset Management;
- ISO 55001 defines the requirements for a "management system" for Asset Management; and
- ISO 55002 provides interpretation and implementation guidance for such a management system.

The key concepts of ISO 55000 and their relationships are shown in Figure 4.7, which shows the integration of various elements of PAM and the Asset Management System within the broader organizational context. The wide range of functions which are included in the AMS should be specifically noted.

ISO 55000 ensures consistency with other related organizational standards such as ISO 9001, 14001 and 31000 . ISO 9001 specifies the requirements for a quality management system, whereas ISO 14001 addresses various aspects of environmental management. ISO 31000[1] provides an organizational risk management framework.

[1]In Section 4.3.5.6 specific reference is made to the role of the ISO 31000 standard within the context of PAM.

Figure 4.8: Examples of key elements within an Asset Management System



Reproduced from IAM (2011)

4.3.4 Asset Management System

The creation of value through the effective management of PAs is complex and requires careful consideration of the trade-offs between performance, cost and risk across all the stages of the asset management life cycle. There are according to PAS-55 (2010) inherent conflicting factors that AM leadership needs to consider. These typically include:

- Short–term vs. long–term benefits;
- Expenditure vs. performance levels;
- Planned vs. unplanned availability; and
- Capital cost vs. operating expenditure.

To complicate matters even further there are also different levels at which PAs are identified and managed ranging from discrete equipment items to complex functional systems and networks deployed over a multitude of sites (PAS-55 (2010)). An integrated AMS is therefore required to co–ordinate and optimize that management of PAs in line with the organizational strategy. The key elements of a typical AMS as defined by PAS-55 (2010) is illustrated in Figure 4.8.

An AMS is thus a set of interrelated elements of an organization, that establish AM policies and objectives, and the processes needed to achieve those objectives. It is important to note that an AMS includes the asset organization structure, roles, responsibilities, capabilities and development plans. In the next section contemporary scope of AM will be evaluated in more detail.

4.3.5 The scope of Asset Management

As indicated above ISO 55000 was published in 2014 and is generally accepted as the new AM standards reference. The Institute for Asset Management (IAM (2011)), however developed a useful conceptual model (see Figure 4.9) to describe the overall scope of AM and the high–level groups of activity that are included within this discipline. This model will be used as a framework when discussing the scope of AM.

The model identifies six AM subject groups namely:

- AM strategy and planning;
- AM decision making;
- AM life cycle management;
- Asset knowledge enablers;
- Organization and people enablers; and
- Risk and review.

The model highlights the fact that AM is about the integration of these groups of activity and not just the activities in isolation.

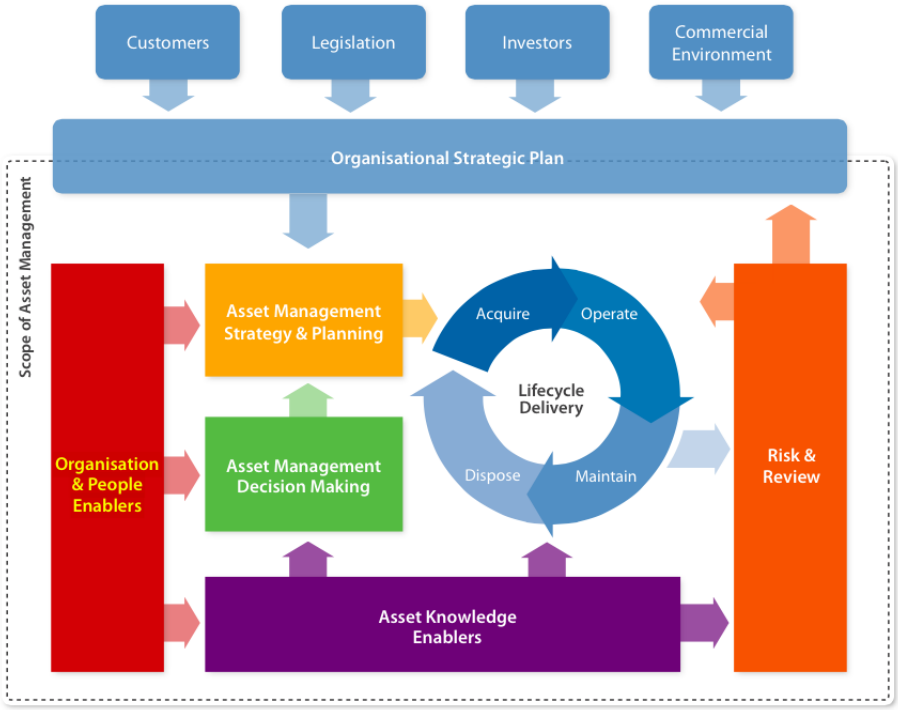
The IAM (2011) has also in conjunction with international partners within the Global Forum for Maintenance and Asset Management (GFMAM) defined 39 subjects that form the core of the Asset Management landscape. The AM subjects are linked to 6 subject groups identified in the the conceptual model. Each one of these subject groups together with the associated subjects will be discussed in the next section. As already noted a detailed discussion of each one of these 39 subjects falls outside the scope of this study.

4.3.5.1 Asset Management strategy and planning

AM strategy and the non-execution of AM strategy is the core focus of this study. Contemporary developments and challenges regarding the subject will thus be discussed in far more detail in Section 4.4. The subject is however briefly introduced in this section.

The AM strategy and planning subject group covers according to the IAM (2011) model the following AM subjects:

Figure 4.9: The scope of Asset Management



Reproduced from IAM (2011)

- Asset Management Policy;
- Asset Management Strategy;
- Demand Analysis;
- Strategic Planning; and
- Asset Management Plans.

AM strategy and planning refers to the core AM activities required to develop, implement and improve AM within an organization. The AM strategy should consider and be aligned to the organizational objectives. The PAM strategy should define both the most important AM goals and objectives, and time frames within which to achieve these (IAM (2011)).

PAS-55 (2010) sets a list of requirements for an AM strategy which fall into seven broad categories:

1. Consistency: The AM strategy should be consistent with the AM policy;
2. Risk-based approach: The AM strategy should be risk-based in its approach, meaning that it should prioritize activities according to the criticality of the asset;
3. Life cycle approach: The life cycle of assets should be specifically considered in the AM strategy;
4. Framework: A clear unambiguous framework should be included within the AM strategy in order to develop AM objectives and plans that set forth the correct level of optimization, prioritization and the management of information;
5. Stakeholders: Involvement of stakeholders is needed within the AM strategy;
6. Functional, performance and condition requirements: The AM strategy should include present and future functional, performance and condition requirements for the assets, a roadmap should also be included as to how these will meet; and
7. Continual improvement: Support from top management, effective communication and regular reviews of the AM strategy are needed.

Davis (2007), contends that AM strategy and planning typically produces an output which explains what the organization plans to do with assets throughout its life cycle (see detailed discussion on AM life cycle in Section 4.3.5.3).

The core contention of all these contributors are the fact that the AM strategy should be deducted from the organizational strategy and that the AM strategy should have an organization wide reach (i.e. AM strategy should not just apply to the maintenance

department as it used to, but must involve the entire organization). In addition hereto the AM strategy should include objectives and plans to manage the asset value creation process throughout the asset life cycle. The implication is that the organizational leadership should thus comprehend both the opportunities and risks inherent in each and every asset.

4.3.5.2 Asset Management Decision–Making

The key to making good AM decisions is acquiring appropriate knowledge[1] and applying this within a robust decision-making framework. The AM decision – making group covers according to the IAM (2011) model the following AM subjects:

- Capital Investment Decision-Making;
- Operations and Maintenance Decision-Making;
- Life Cycle Cost and Value optimization;
- Resourcing Strategy and optimization;
- Shutdowns and Outage Strategy and optimization; and
- Ageing Assets Strategy.

Over the past decades the importance of, and challenges involved in, the development of such an appropriate decision–making framework has been a core theme in not only AM literature but in organizational and management literature in general. As indicated in Section 2.4.6.1, Simon (1977) was one of the first contributors to define both the decision making process and different types of managerial decisions. According to him the decision making process consists of three phases:

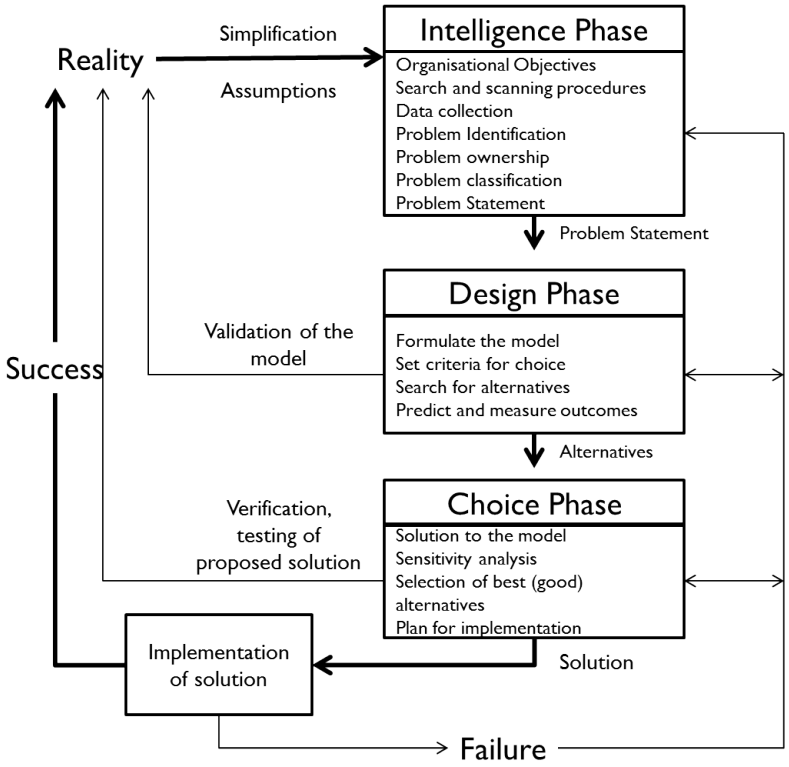
1. Intelligence: searching for conditions that call for decisions;
2. Design: inventing, developing and analyzing possible courses of action; and
3. Choice: selecting a course of action from those available.

A fourth phase, *"implementation"*, was added later. A conceptual model of the decision making process as conceptualized by Simon was presented in Section 2.4.6.1 and reproduced in Figure 4.10 for ease of reference.

Simon (1977) also identified three types of managerial decisions:

[1] Access to data, information and knowledge (collectively referred to by the IAM (2011) as Knowledge Enablers (KE) and identified as one of the AM subject groups, is thus of vital importance during the decision making process. In this section the focus falls on the decision–making process itself. Asset Knowledge Enablers (AKE) are discussed in more detail in Section 4.3.5.4.

Figure 4.10: The decision making/modelling process



Reproduced from Turban et al. (2007).

- Structured;
- Semi-structured; and
- Un-structured.

As indicated in Section 2.4.2, Anthony (1965) drew boundaries between management control, strategic planning and operational control. He is of the opinion that management control is contrasted with the ideas of strategic planning, concerned with setting goals and objectives for the whole organization over the long term, and operational control, concerned with ensuring that immediate tasks are carried out.

Gorry & Morton (1971) combined the work of Anthony (1965) and Simon (1977) and developed a basic decision making framework. The framework was presented in Table 2.7 and is reproduced in Table 4.2 for ease of reference. In the framework the authors used Simon's three types of decision on the vertical axis and Anthony's three types of management control on the horizontal axis.

Table 4.2: Framework for decision making

Type of decision	**Operational control**	**Managerial control**	**Strategic planning**
Structured	Accounts receivable, order entry	Budget analysis, short term forecasting, personnel reports, make or buy	Financial management (investment), warehouse location, distribution systems
Semi-structured	Production scheduling, inventory control	Credit evaluation, budget preparation, plant layout, project scheduling, reward system design	Building new plant, mergers and acquisitions, new product planning, compensation planning, quality assurance planning
Un-structured	Selecting a cover for a magazine, buying software, approving loans	Negotiating, recruiting an executive, buying hardware, lobbying	R&D planning, new technology development, social responsibility planning

Adapted Turban et al. (2007)

The implication of the framework developed by Gorry & Morton (1971) is that decision making methodologies are not the same for all types of organizational decisions. Decisions taken within a structured environment, where clearly defined operational protocols are available, are far less complex than decision taken within a totally unstructured environment, where decision makers have no or little previous experience or protocols to refer to.

AM decisions are no different to any other organizational decisions and AM leadership are faced with the same decision making challenges and utilizes the same decision making

methodologies and aids described in Section 2.4.6.1. As indicated in Section 4.3.4 PAS-55 (2010) contends that it is possible to delineate at least three levels of AM decision making complexity:

- Level 1: Individual asset decisions;
- Level 2: Asset system decisions; and
- Level 3: Asset portfolio decisions.

Table 4.3 describes the typical decisions AM leadership have to contend with at each one of these levels:

Table 4.3: Typical AM decision complexity matrix

AM Decision Complexity Level	**Typical AM Decisions**
Level 1: Individual asset decision	• Asset life cycle costs; and • Risk and & performance.
Level 2: Asset system decision	• Systems performance; and • Cost & risk optimization.
Level 3: Asset portfolio decisions	• Capital investment value; and • Performance and sustainability.

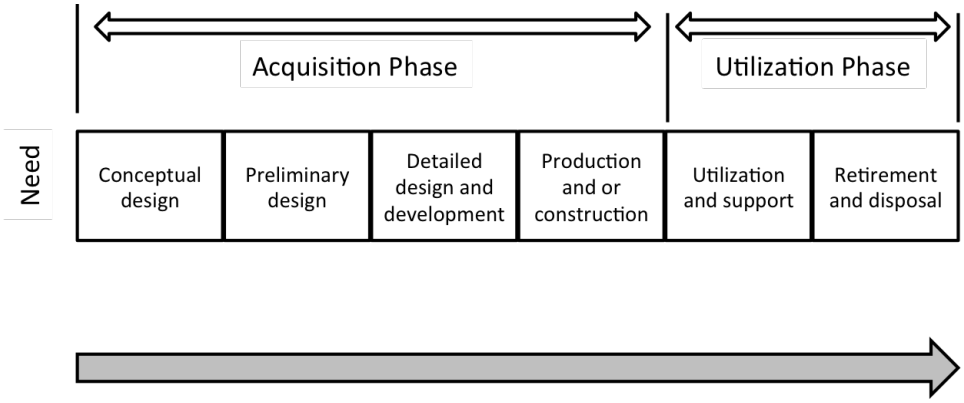
Reproduced PAS-55 (2004)

A detailed discussion of various AM Decision Support System (DSS)s and methodologies falls outside the scope of this section. Suffice to conclude that AM Decision–Making, is important at all stages of the Asset Management Life Cycle and should be made to ensure optimized asset value contribution, while considering all inherent constraints including market conditions, statutory legislation, regulatory obligations, limited access to resources and the like. AM decisions should be taken with a full understanding of the AM strategy.

4.3.5.3 Asset Management Life Cycle

The collective term used to describe the management of assets under the control of the organization is according to ISO (2014) the Asset Management Life Cycle (AMLC). In the discussion in Section 4.3.5.2 it was highlighted that AM Decision–Making requires AM leadership to make many the trade-off decisions. However, it is according to the IAM (2011) the AMLC delivery activities that present both:

Figure 4.11: Life cycle phases of physical assets



Adapted from Blanchard & Fabrycky (1998)

- The most significant opportunities to identify efficiencies through the adoption of good practice AM; and
- The most significant risks of increasing costs and risks of asset failure if these delivery activities are not well managed.

Blanchard & Fabrycky (1998) emphasize the importance of Least Common Multiple (LCM) within the context of AM. In their opinion the asset management process should extend from design, procurement and installation through operation, maintenance and retirement, i.e. over the complete asset life cycle. They use the traditional system life cycle model, (see Figure 4.11) to illustrate their view.

Schuman & Brent (2005) in principle agree with the views of Blanchard & Fabrycky (1998), but they recommend even higher levels of integration by proposing a holistic AMLC model for Physical Assets by aligning and integrating the relevant elements of project management, logistics engineering, systems engineering, maintenance management and life cycle costing. A comprehensive Least Common Multiple approach according to them assures that the processes used across projects are consistent and that there is effective sharing and coordination of resources, information and technologies.

An analysis of AM literature illustrates that the vast majority as contemporary contributions deals with issue regarding the management of AMLC delivery activities. These activities include according to the IAM (2011) model the following AM subjects:

- Technical Standards and Legislation;
- Asset Creation and Acquisition;
- Systems Engineering;

- Configuration Management;
- Maintenance Delivery (See McKone & Weiss (2002) and Zhou *et al.* (2007));
- Reliability Engineering and Root Cause Analysis (See (Øien (1998));
- Asset Operations;
- Resource Management;
- Shutdown/Outage Management (See Keshavarz *et al.* (2012); Hameed & Khan (2014))
- Incident Response; and
- Asset Rationalization and Disposal (See Dwight & El-Akruti (2009).

A detailed evaluation of each of these activities falls outside the scope of this discussion.

4.3.5.4 Asset Knowledge Enablers (AKE)

As indicated in Section 4.3.5.2, the key to making good Asset Management decisions is access to appropriate information. Asset intensive organizations rely on asset data, information and ultimately asset knowledge as key enablers in undertaking both strategic AM activities and operational AM activities.

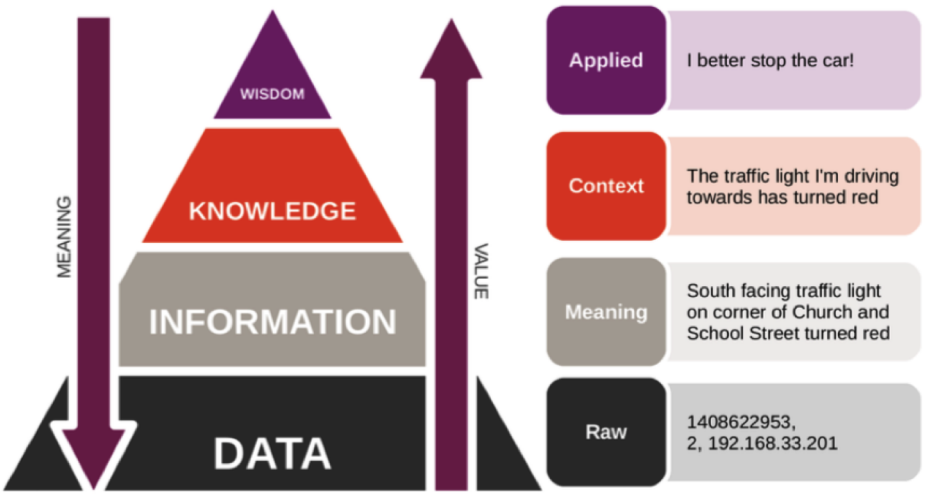
It is possible to make a distinction between the following four AKE categories:

- **Data** – Numbers, words, symbols and pictures, without context or meaning, i.e. data in a raw format, e.g. 25 metres;
- **Information** – A collection of data expressed with a supporting context e.g. The span of the bridge is 25 metres; and
- **Knowledge** – A combination of experience, values, information in context, and insight that form a basis for decision making.
- **Wisdom** – Wisdom in this context refer to the appropriate application of data, information and knowledge.

This transformation is illustrated in Figure 4.12. The effective management of AKErequires:

- The formulation of an Asset Information Strategy (AIS);
- Definition of asset knowledge standards;

Figure 4.12: The transformation from Data to Knowledge



- Availability of an asset information system(s);
- Access to quality asset data and knowledge.

These requirements are generic to the development of all organizational knowledge management processes and systems. A detailed evaluation of the knowledge management however falls outside the scope of this study.

4.3.5.5 Organization and People Enablers

According to the IAM (2011) model, the Organization and People Enablers subject group include the following subjects:

- Contract and Supplier Management (Martin 1997; Buczkowski, Hartman et al. 2005);
- Asset Management Leadership;
- Organizational Structure and Culture; and
- Competence and Behaviour.

Within contemporary organizational management literature these topics are typically discussed as part of the the subject Organizational Design (OD) and research in this regard is clear that even the most cunning strategy will not reach its potential if an

organization's design do not support it (see Gulati *et al.* (2012), Bartlett & Ghoshal (2013), Mansfield (2013) and Worley & Lawler III (2010)). However, the complexity, unpredictability, and instability of environmental change seem to have outpaced our traditional Organizational Design approaches and concepts. Executives are according to Worley & Lawler III (2010) struggling to design firms that are efficient enough to drive performance in the short run and flexible enough to sustain performance over the long run. Organizational Design needs to embrace the principles of agility[1] to just to survive, let alone thrive.

Grant (2010) concurs with Worley & Lawler III (2010) and in Section 2.2.3 his views regarding contemporary organization design challenges were duly noted. Within this context the building of outstanding and adaptive capabilities should be the primary function of organizational design. According to IAM (2011), Mitchell *et al.* (2007), Amadi-Echendu *et al.* (2010), Hastings (2010) the same principles should be applied when designing the contemporary asset management organization[2].

4.3.5.6 Risk and Review

ISO 31000 ISO (2009)[3] defines risk as:

> *"...the effect of uncertainty on objectives..."*,

whether these effects are positive or negative.

Jaafari (2001) defines risk as:

> *"...the exposure to loss or gain, or the probability of occurrence of loss/gain multiplied by its respective magnitude..."*

Events are said to be certain if the probability of their occurrence is 100% known or totally uncertain if the probability of occurrence is unknown. In between these extremes the uncertainty varies quite widely.

[1]The concept organizational agility was introduced in Section 2.3.2 and will not be discussed in detail in this section, suffice to conclude that agility is a dynamic organization design capability that can sense the need for change from both internal and external sources, carry out those changes routinely, and sustain above–average performance. The final characteristic (sustained above – average performance), is the *"sine qua non"* of agility. Many firms are able to push their performance to above average in the short run, the real issue is dynamically aligning structures, processes, and systems to sustain it (Worley & Lawler III (2010)).

[2]The following contributions regarding people, organization and performance are not referred to specifically in this section but should be noted, Pintelon & Van Puyvelde (1997),Muchiri *et al.* (2011), and Garg & Deshmukh (2006b).

[3]The ISO 31000 standard was introduced in 2009 and is intended to help organizations to manage in a systematic and comprehensive manner diverse types of risk by offering a universal framework to assist the organization to integrate risk management into its overall management system.

The purpose of risk management is according to Connor & Korajczyk (2003) and Shah & Littlefield (2009) not to eliminate risk, since that would be impossible, but rather to decide which risks are worth taking and which ones to avoid completely. Hubbard (2009) thus describe risk management as the identification, assessment, and prioritization of risks, followed by coordinated and economical application of resources to minimize, monitor, and control the probability and/or impact of unfortunate events.

The Porter Value Chain is discussed in detail in Section 2.2.2.6, and it is a useful framework to describe the organizational value creation process. At the strategic level AM has a critical role to play during every stage of the value creation process by ensuring a balance between utilizing installed capacity, market dynamics and customer needs. Strategic AM activities involve time frames spanning several years and AM leadership should thus in addition to ensuring the availability and reliability of appropriate equipment to cater for the current organizational needs, consider product mix and demand characteristics, plant units and production capacity, distribution system, and out–sourcing strategies Jaafari (2001).

Risk is inherent to each on of these value creation processes and are influenced by internal as well as external constraints and limitations such as price changes, and demand fluctuations, ageing equipment, reliability issues, quality of products and rapid obsolescence.

In addition to the business and financial risks that are inherent to every stage of the value creation process the following risks are inherent to the use of PAs:

- Health and Safety;
- Environmental damage; and
- Reputation damage caused by incidents resulting in either illness, injury or environmental damage;

The Risk and Review subject group is thus a critical element within the IAM model. The mapping and comprehension of the risks inherent in AM facilitates the AM Decision–Making process and aid AM leadership during the the constant trade-off between performance, cost and risk. The development and maintenance of appropriate feedback and review mechanisms facilitate the adaptation of objectives and evolution of understanding of asset criticality to the delivery of the business aims (IAM (2011)).

The Risk and Review subject group includes the following AM subjects:

- Criticality, Risk Assessment and Management;
- Contingency Planning and Resilience Analysis;
- Sustainable Development;

- Weather and Climate Change;
- Assets and Systems Performance andHealth Monitoring;
- Assets and Systems Change Management;
- Management Review, Audit and Assurance;
- Accounting Practices; and
- Stakeholder Relations.

The Multivariate Asset Management Assessment Topograhpy (MAMAT) was recently developed by the Asset Care Research Group (ACRG) at Stellenbosch University as a mechanism that can be utilized to assist organization with the identification and management risk inherent to PAs. The MAMAT is based on the IAM's PAS 55 assessment methodology, but extends its one–dimensional structure to a more thorough multi-dimensional assessment tool that serves as a guide for effective improvement action (Bam & Vlok (2014)[1]. A typical output from the MAMAT is presented in Figure 4.13

A detailed evaluation of the MAMAT falls outside the scope of this study, but the methodology was found to be extremely useful and applicable during the development of the screening instrument for PAMSEF.

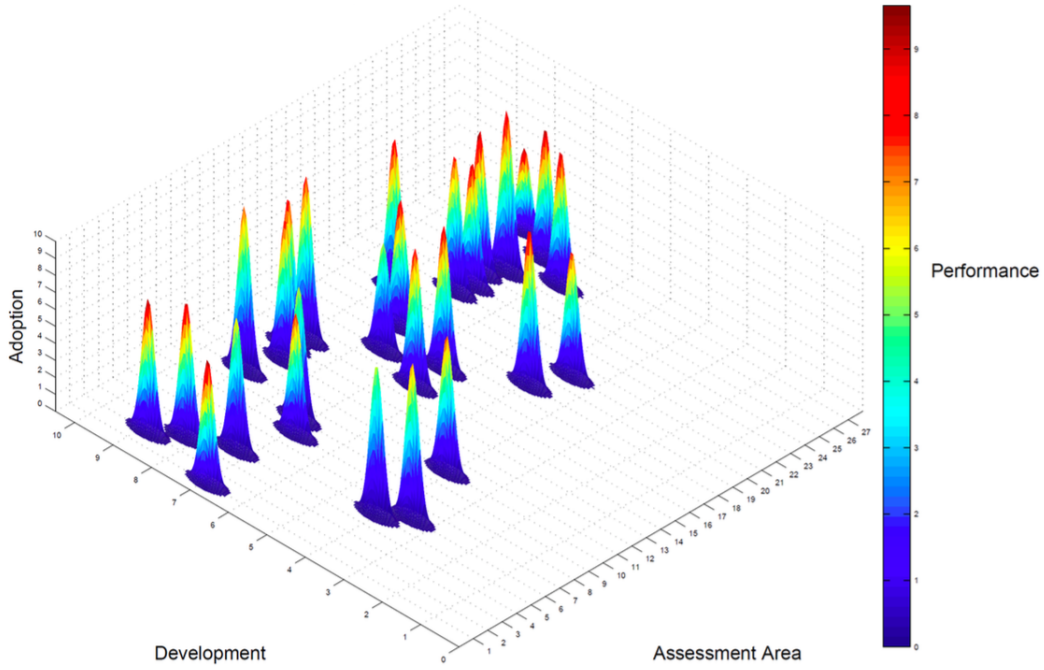
Each one of the MAMAT dimensions are measured using a 5 level Likert[2] scale. A Likert scale is the sum of responses on several Likert Item (LI)s. A LI is simply a statement that the respondent is asked to evaluate by giving it a quantitative value on any kind of subjective or objective dimension, with level of agreement/disagreement being the dimension most commonly used (Burns & Bush (2006)). The format of a typical five-level LI, for example, could be:

1. Strongly disagree;
2. Disagree;
3. Neither agree nor disagree;

[1]To visualise assessment data, the PAS 55 assessment methodology makes use of radar/spider graphs. Spider graphs promote according to Bam & Vlok (2014), comparison across multiple dimensions, unlike line or bar graphs, but they may lead to visual confusion. Furthermore, such a chart cannot display additional assessment dimensions, and can become difficult to interpret. Each MAMAT assessment area, is assessed in three-dimensions – development, adoption, and performance. When the three dimensional results for each assessment area are plotted on the same graph, this results in a four-dimensional graph, with the assessment area constituting the fourth dimension. Time can be added as an additional dimension where snapshots from different periods of the assessment are compared.

[2]The Likert scale was developed by Rensis Likert an American administrator and organizational psychologist and is widely used in research where respondents are required to complete questionnaires Wuensch (2005)

Figure 4.13: Example of MAMAT output



4. Agree; and

5. Strongly agree.

In the next section PAM strategy will be delineated within the context of the organizational strategy and within the context of contemporary strategy discourse.

4.4 PAM strategy within the context of organizational strategy

In Section 2.1 it was confirmed that the field of strategy is undoubtedly one of the most chronicled subjects in the business world. From the huge body of information on the topic it is important to distill what is most critical for the discussion at hand. The analysis and presentation of relevant data often poses significant challenges. The framework presented in Table 2.9, illustrates the evolution of business strategy thinking since the turn of the 20^{th} century. In the discussion of organizational strategy the focus fell on three important strategy elements:

- The evolution of strategy paradigms;

- The evolution of Organizational Design paradigms; and
- The evolution of Management Control Systems.

Despite the calls for a more integrated and holistic approach to AM, the field of AM strategy is however according to Frolov *et al.* (2010) and El-Akruti (2012) far less chronicled and as indicated in Section 4.3.5.3, the majority of AM research seem to focus on those technical aspects that are dealt with under the heading Asset Management Life Cycle activities.

These contributors furthermore contend that there is a lack of research on the relationship between organizational strategy and AM activities or asset related activities in general.

Despite the fact that the AM strategy Body of Knowledge is far smaller than the BOK for general organizational strategy it was decided to present the available AM strategy contributions, using a similar framework to the one developed to present general organizational strategy. The use of a similar framework aids the process of comparison and contextualization.

In the following sections those contributions that have been made will be discussed under the following headings:

- The evolution of AM strategy paradigms;
- The evolution of AM Organizational Design paradigms; and
- The evolution of AM Management Control Systems;

4.4.1 The evolution of AM strategy paradigms

In Chapter 2 it was noted that one of the first known applications of strategy to the business world occurred when the greek businessman Nichomachides lost an election to the position of General to Antisthenes in 480 BC. Nichomachides seeked consolation from Socrates. During the conversation that followed Socrates compared the duties of a businessman and a general and illustrated that in either case one plans to use one's resources to meet objectives. It was however also noted in Section 2.2.1 that the adoption of strategic terminology in the general business context had to await the so-called "Second Industrial Revolution" which only began in the second half of the 19^{th} century but really took off only in the 20^{th} century.

Prior to the Industrial Revolution, maintenance consisted according to Sherwin (2000) of individual craftsmen such as carpenters, smiths, coopers, wheelwrights and masons, repairing the buildings, primitive machines and vehicles of the day. At the time there was no real understanding of the importance of spare parts. When failures occurred new parts were manufactured or attempts were made to repair old ones. At the time basic

structures was highly durable and assemblies were seldom discarded[1]. It should also be noted that craftsmen had no way of calculating stresses at the time, the implication was they would fit stronger parts to replace failed parts, and these "learnings" were then incorporated when new machines were designed.

The construction of railroads in the United States after 1850 created the infrastructure to enable mass markets. Mass markets together with access to capital and credit encouraged small business to invest in large scale fixed capital. This in turn enabled firms to exploit economies of scale in production and economies of scope in distribution (McCraw (1997)).

By the late 19^{th} century a new type of firm emerged – first in the United States and later in Europe. This new firm employed far more people, made massive investments in manufacturing and marketing as well as management hierarchies to co-ordinate all functions.

In the next section the milestones, developments and characteristics of PAM strategy are compared to the general organizational strategy developments and characteristics discussed in Chapter 2. The framework presented in Table 2.9 (Section 2.5), referred to three important periods:

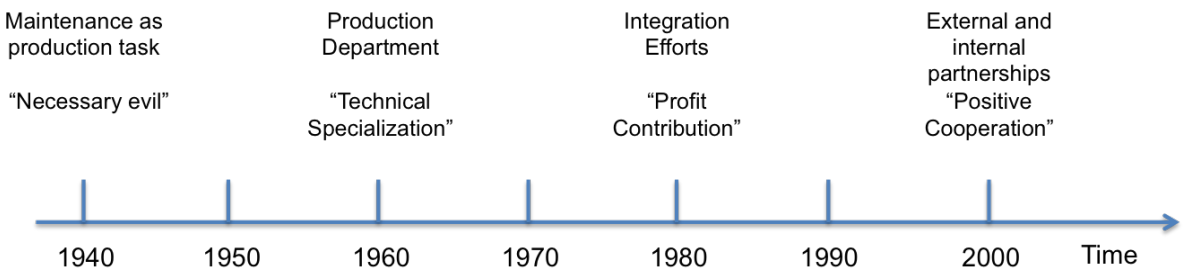
- The Modern Organization (MO) (1900–1945);
- The Bureaucratic Organization (BO) (1945–1990); and
- The Contemporary Organization (CO) (1990–current).

Pintelon & Parodi-Herz (2008) develop a very useful timeline (presented in Figure 4.14) to illustrate the changing perceptions regarding PAM value add within the organization over the past seven decades.

For the sake of comparison the time periods referred to in the Table 2.9 will however be used.

[1]In this regard Sherwin (2000) for example refers to the flagship in Lord Nelsons fleet – the HMS Victory. The ship was the result of more than 300 years of slow design evolution and was already 40 years old at the battle of Trafalgar in 1805. This was about the average age for all ships taking part in the battle. The HMS Vicotry remained in service until the development of steam power and iron hulls in 1860, but remained afloat until 1922 when she was dry-docked and restored. Over the years in service and preservation, almost all of her original structure has been replaced by new wood, some of it more than once. The maintenance policy was possible because even skilled labour was cheap relative to the utility value of assets. An idea of the asset value of HMS Victory can be gained from the fact that her timber came from the felling of trees 30-50 years old covering about 40 hectares. These trees required some specialized pruning and training when young to cause them to grow to the required shapes. About 60 men would have worked for over 6 years to build her hull.

Figure 4.14: Asset management time–line



Adapted from Pintelon & Parodi-Herz (2008)

4.4.1.1 The Modern Organization (1900–1945)

In order to assist the reader a short summary of developments in the field of general organizational strategy paradigms in the period 1900–1945, (as discussed in detail in Chapter 2), will firstly be provided.

General Organizational Strategy:

- Very few theoretical contributions;
- Market conditions relatively uncontrolled;
- Adam Smith described market forces as an "invisible hand";
- Firms did not really use or needed real strategic methodology.

PAM Strategy:

Up to World War II industrial developments were relatively limited and asset maintenance was seen as a *"necessary evil"*. There were no dedicated maintenance resources and no evidence of any scientific approach to maintenance.

In 1937 the Bawdsey Research Station in the United Kingdom (UK) under the leadership of A.P Rowe however conceived the idea of Operations Research (OR) as part of an attempt to analyze and improve the working of early warning systems in the UK. OR was defined by its originators as:

"...the application of scientific method to operational problems..."

OR was according to McCloskey (1954) first applied to maintenance during WWII. He cites the impact OR had on the maintenance strategy of combat aircraft. Scientist from completely different backgrounds using scientific methods, (i.e. inductive reasoning and calculations based upon real-life data), advised reducing the maintenance given to combat aircraft on the grounds that most of them would be destroyed before anything vital wore out. The wartime strategy, to get air craft back in the air as quickly and as often as possible, was diametrically different from the peacetime strategy of sustaining readiness. Using the scientific method they thus worked out which maintenance activities should be dropped and which routines could be done at what increased intervals to support the relevant strategy.

After WWII the pace of change within the business eco-sphere started to pick up. Ansoff (1957) is of the opinion that the accelerated application of science and technology in the process of business management had a major impact on the dynamics within the business environment in this period.

The increased rate of change implied that those managers that were able to predict the uncertain future better would be better positioned to develop plans and programmes to respond to these changing conditions, and to avoid the risks and threats inherent in a changing landscape. The application of new analytical tools and techniques, such as linear programming, cost-benefit analysis, and discounted cash-flow techniques (that typically had their origin during WWII), empowered managers to make better and more informed decisions.

It is however important to note that although WWII developments are often seen as the catalyst for changes in the manufacturing and maintenance landscape, scientific maintenance principles were only applied more consistently within the context of the Bureaucratic Organization.

4.4.1.2 The Bureaucratic Organization (1945–1990)

In order to assist the reader a short summary of developments in the field of general organizational strategy in the period 1945–1990, (as discussed in detail in Chapter 2), will firstly be provided.

General Organizational Strategy:

- Strategy paradigms evolved from corporate planning in the 1960's, to diversification and portfolio planning in the 1970's;
- During the early 1980's the dominant strategy contributions the Industrial Organization (IO) movement.
- During the late 1980's and early 1990's the focus shifted inward. The dominant discourse revolved the *"resource based view of the firm"*

PAM Strategy:

The developments within the AM environment during this period should be seen within the context of changes in the business landscape at the time. As illustrated in Section 2.2.2.1 business leaders during this period relied very strongly on the application of military strategy principles within the business world, i.e. the optimal application of resources in an attempt to reach organizational goals and objectives.

As organizational efficiency increased (the result of improved corporate planning), businesses increasingly embarked on so-called diversification campaigns. The diversification efforts however introduced new levels of complexity and decision makers thus required new strategy models and aids.

As indicated in Section 2.2.2, most developments in strategy analysis in the early 1980s focused on the industry environment of the firm and it's competitive positioning relative to rivals. The strategic analysis of the firm's internal environment remained largely underdeveloped. Internal analysis, including the development of the ideal organizational structure, systems of control and management style was viewed as a consequence of the adopted strategy and was thus not regarded as a source(s) of competitive advantage (Grant (2010)).

The widespread mechanization and automation that characterized this period had according to Garg & Deshmukh (2006b) a number of PAM consequences:

- Organization required staff with higher levels of technical knowledge and specialization;
- The number of production personnel has diminished over this period;
- The proportion of employees working in the area of maintenance relative the areas of production increased;
- There has been a significant increase in the capital employed in production equipment and civil structures;
- The proportion of AM spending relative to the total operational costs increased; and

- This period saw the introduction of the so-called "Maintenance Department", within many organizations.

Since the late 1980s there has however been a significant focus on the role of internal resources and capabilities as the basis for strategy and determinant for profitability. Barney (1991), described the *"resource based view of the firm"*. Exponents of this view of the organization are of the opinion that within the context of volatile customer expectations and a dynamic external environment, the firm itself, in terms of its resources and capabilities, may be a far more stable basis to define it's identity and offer a more durable basis for strategy.

While conventional approaches to competitive advantage focus upon so-called generic sources of competitive advantage – namely, cost and differentiation advantage (see Porter (1981)), it has thus for long been the contention of academics and management practitioners that organizations perform better and create more value when they implement strategies that are responsive to market opportunities by exploiting their internal resources and capabilities (assets) (Penrose (1959), Andrews (1971), Barney (1991), and Armstrong & Taylor (2014)). The implication is thus that the decision makers within an organization need to:

- Develop an inventory of internal resources (see detailed discussion in Section 4.1); and
- Understand how these resources work together to create competitive capabilities (see detailed discussion in Section 4.2.

As can be expected the potential value that could be unlocked through optimized PAM also came under the spotlight during this period and there was according to Sherwin (2000) a revival of interest in maintenance optimization among non–engineers during this period, very similar to the interest taken by non–engineers in the maintenance of combat aircraft during WWII (discussed above). The response from the engineering world to the renewed interest was according to Sherwin (2000) only lukewarm, for the following reasons:

- **Applicability**: the contributions were often very theoretical, and the proposed optimization models were dependent and data that was generally not available. This reality made most of these contributions impractical;
- **Accessibility**: many of the contributions were published in journals that were not read by – or accessible to – maintenance engineers;
- **Motivational**: many of the models were exercises in advanced mathematics and were not really focused on solving the problems faced by maintenance engineers on a daily basis.

Despite the fact that engineers did not really embrace the interest from non-engineers and more specifically mathematicians in their field a paradigm shift regarding the value of PAs started to take place. In line with the timeline developed by Pintelon & Van Puyvelde (1997), PAM was no longer seen as merely a *"necessary evil"*, nor the responsibility of the *"maintenance department"*, but academics and practitioners began to understand and emphasize the potential value of PAs as *"profit contributors"*.

Towards the late eighties and early nineties the conventional wisdom embracing the concept of *"economy of scale"* was also losing followers. Academics and practitioners started to embrace the theory and practice of *"lean manufacturing"*, *"just-in-time production"* and *"Six Sigma $(6-\sigma)$"*. These trends required a different attitude and response from maintenance engineers. Executives and more specifically maintenance practitioners began to comprehend that the reliability and availability of plant were vitally crucial. Poor machine performance, downtime and ineffective plant maintenance lead to a loss of production, decrease in organizational profitability, and ultimately loss of market opportunities (Tsang (2002), Cholasuke *et al.* (2004)).

Many authors during this period provided explanations on why and how maintenance management could maximize business profit (Wilson (1999), Willmott (1994), Dunn (1996) and Levitt (2009)). Cholasuke *et al.* (2004) developed a model (see Figure 4.15), based on the contribution of many late nineties contributors to illustrate the way in which successful maintenance management could contribute to organizational profit.

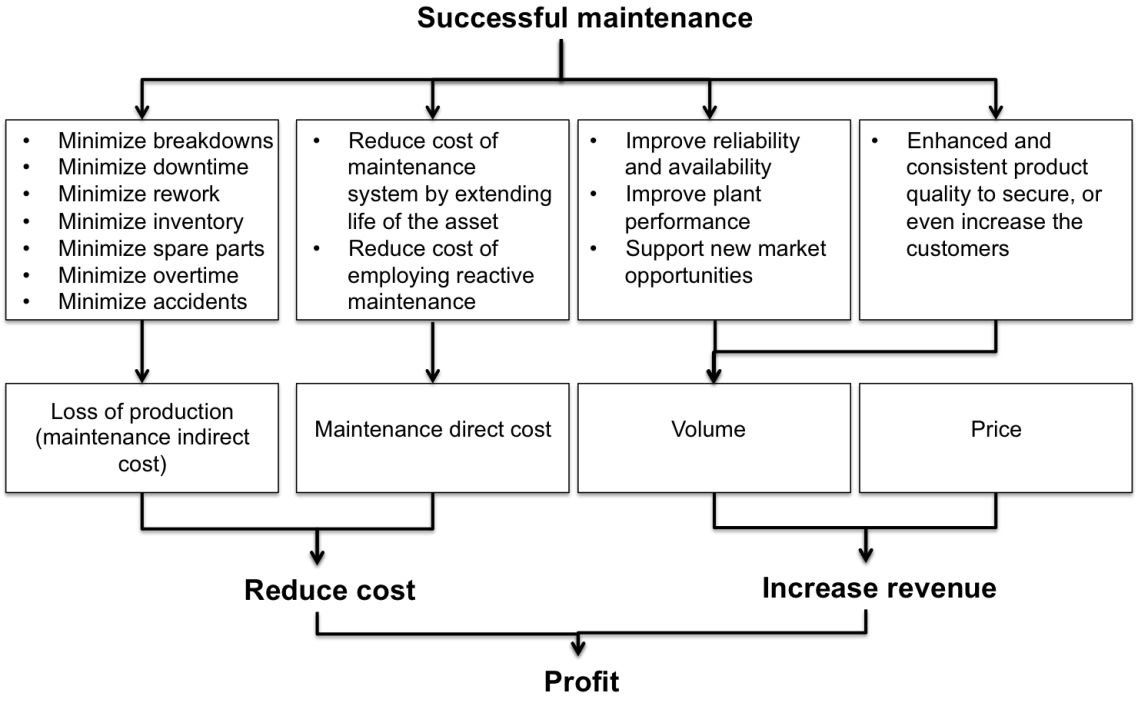
It is important to note that very few if any contributors have up to this point made any reference to the concept Physical Asset Management. Academics and practitioners illustrated a good understanding of the importance of asset maintenance as an important source of value but is was not until the publication of the PAS 55 in 2004 that the PAM discipline really got both academic and industry traction.

4.4.1.3 The Contemporary Organization (1990–current)

In order to assist the reader a short summary of contemporary developments in the field of general organizational strategy paradigms, (as discussed in detail in Chapter 2), will firstly be provided.

General Organizational Strategy:

Figure 4.15: Maintenance management contribution to organization profit



Adapted from Cholasuke et al. (2004)

> The rate of change increased dramatically and this led to the deconstruction of existing paradigms. Turbulence has become the hallmark of the contemporary business environment. In these uncertain time, organizations are under constant pressure to continuously enhance their capability to create value and while ensuring cost effectiveness. The focus within the contemporary organization is no longer on the definition of a grand plan, but rather the continuous generation of innovative and new ideas that would surprise the competition and delight the customers.

PAM Strategy:

The contemporary business environment has raised the strategic importance of the PAM function in organizations which have significant investment in Physical Assets. Organizations the world over are increasingly becoming more and more capital intensive and it has been found in various studies that spending on assets and asset maintenance has been increasing steadily over the past number of decades (Tsang (2002); Dekker (1996) and Cross (1988)).

In addition to the fact that organizations become more asset intensive over the years the following contemporary developments forced academics and practitioners according to Tsang (2002), to finally redefine their views on maintenance:

- **Emerging trends of operation strategies**: As indicated in Section 4.4.1.2 academics and practitioners started to embrace the theory and practice of *"lean manufacturing"*, *"just-in-time production"* and *"Six Sigma* $(6-\sigma)$*"*. These trends required a different attitude and response from maintenance engineers. Executives and more specifically maintenance practitioners began to comprehend that the reliability and availability of plant were vitally crucial.

- **Toughening societal expectations**: The pressure on organizations to protect the environment and ensure the safety and health of people that work in the organization is ever increasing. In most countries organizations need to abide to a range of very strict domestic as well as international rules and regulations to control industrial pollution and prevent accidents in the workplace. Scrap, defects, and inefficient use of materials and energy are sources of pollution. Apart from producing waste material, catastrophic failures of operating plant and machinery are also the major cause of industrial accidents and health hazards. Ensuring that PA are in optimal condition and preventing failures do thus no longer only make good business sense but has become a legal requirement.

- **Technological changes**: Technology has always been a major driver of change. Technology developments within the PAM environment include non-destructive testing, transducers, vibration measurement, thermography, ferrography and spectroscopy. All these development make non-intrusive inspection possible and the

application of these technologies ensures that the condition of equipment can be monitored continuously or intermittently while it is in operation. These developments resulted in the establishment of new protocols and disciplines such as condition–based maintenance.

Within this context PAM has become an critical support function. The definition of relevant and adaptive PAM strategies is thus critical to to long term success of any asset intensive organization. It is within this context that the Institute for Asset Management, together with the British Standards organization and other collaborating organizations published PAS-55 (2004) in 2004 as a first attempt to define a PAM industry standard framework.

The Institute for Asset Management (IAM) (IAM (2011)), defines Asset Management Strategy (AMST)[1] as follows:

> *"Long term optimized approach to the management of assets, derived from, and consistent with the organizational strategic plan and the asset management policy"*

According to the IAM the AMST converts the objectives of the organizational strategic plan and the asset management policy into a high-level, long-term action plans for the assets and/or asset system(s), the asset portfolios and/or the asset management system.

The high-level, long-term action plans for the assets and the asset management objectives are normally the outputs of the AMST. These elements together form the basis for developing more specific and detailed asset management plan(s).

According to Wenzler (2005), the AMST is a capability required to identify, design, construct, operate, and maintain all asset classes within an organization.

> *"The purpose of Asset Management Strategy is to generate optimal and sustainable financial returns and at the same ensure that pre-determined performance standards are met."*

Hastings (2010) raises a number of concerns regarding PAM within the context of the wider business strategy. He points out that business functions such as sales, operations, finance and human resource management may be clearly present in the business structure. PAM in turn may decay as a "grey area" between strategic and operational activities. Spanning across different functions, PAM becomes a matrix activity that is more difficult to grasp.

As indicated in Section 4.3.5.1 PAS-55 (2010) sets a list of requirements for an AM strategy which fall into seven broad categories:

[1]For the purpose of this text the acronym AMST will be used when reference is made to the concept Asset Management Strategy. The acronym AMS was defined in Section 4.3.4 and refers to Asset Management System.

Table 4.4: AM Strategy requirements

Category	Requirement
Consistency	The AM strategy should be consistent with the AM policy.
Risk-based approach	The AM strategy should be risk-based in its approach meaning that it should prioritize activities according to the criticality of the asset.
Life cycle approach	The life cycle of assets should be specifically considered in the AM strategy.
Framework	A clear unambiguous framework should be included within the AM strategy in order to develop AM objectives and plans that set forth the correct level of optimization, prioritization and the management of information.
Stakeholders	Involvement of stakeholders is needed within the AM strategy.
Functional, performance and condition requirements	The AM strategy should include present and future functional, performance and condition requirements for the assets, a roadmap should also be included as to how these will meet.
Continual improvement	Support from top management, effective communication and regular reviews of the AM strategy are needed.

PAS-55 (2010) states that an AMS is vital to master the complexity and diversity of assets in consideration of the organizational objectives.

In line with PAS 55, an AMS is defined as the organizations physical asset management policy, physical asset management strategy, physical asset management objectives, physical asset management plan(s) and the activities, processes and organizational structures necessary for their development, implementation and continual improvement.

Organizations are continuously evol

In the next section the focus fall on the evolution of PAM organizational design paradigms and on the impact this evolution had on contemporary PAM strategy realities and challanges.

4.4.2 The evolution of PAM Organizational Design paradigms

In Section 2.3 it was noted that Organizational Design paradigms have evolved over the past 120 years, initially in response to changes within in the strategy landscape and later on as a catalyst for change within the strategy landscape.

The strategic decisions involved in the OD and structuring of maintenance work in-

clude according to Tsang (2002):

- Plant specialization;
- Workforce location;
- Composition and flexibility of workforce.

These decisions are in turn influenced by factors such as workload, plant location, cost of unavailability, skills and knowledge required, production policy and human resource policy.

In this section the milestones, developments and characteristics of PAM organizational design paradigms are compared to the general organizational design developments and characteristics discussed in Chapter 2. For the sake of comparison the time periods referred to in the Table 2.9 will also be used in this section.

The framework presented in Table 2.9 (Section 2.5), referred to three important periods:

- The Modern Organization (1900–1945);
- The Bureaucratic Organization (1945–1990); and
- The Contemporary Organization(1990–current).

4.4.2.1 The Modern Organization (1900–1945)

In order to assist the reader a short summary of developments in the field of general organizational design paradigms in the period 1900–1945, (as discussed in detail in Chapter 2), will firstly be provided.

General Organizational Design:

Organization design paradigms during this period were mostly influenced by the ideas of FW Taylor and Weber. Taylor conceptualized Scientific Management (SM)[1]. SM consisted of four principles:

- Work methods are based on scientific study of task;
- Scientifically train workers;
- Provide detail instructions; and
- Divide work and responsibility between thinking and doing.

Scientific management was however resisted at grass root level, by both workers and managers because it fundamentally ignored the nature of work as a social process, it had a dehumanized view of workers and treated work motivation in crude instrumental terms (see (Marshall (1994)) and (Braverman (1998)).
Initially most companies were small and operated from a single plant or office. The invention of the railroad and the telegraph had a dramatic impact on this reality and organizations had the ability to operate over a far wider geographical area. The implication of this was however the need for new organizational structure types and management systems.
Weber promulgated the concept bureaucracy in the early part of the previous century. In his conception of the ideal bureaucracy Weber made a clear distinction between line and staff functions. An organization formed on these principles would thus have clearly defined jobs, clear lines of communication and authority (centralization and hierarchy) and clear division of labour (Keats & O'Neill (2001)).
Despite the critique against the ideas propagated by both Taylor and Weber, their work did not only had a significant impact on the way in which organizations were designed in the period 1900–1945. *"Line and Staff Structures"* are still a common characteristic of many contemporary organizations.

PAM Organizational Design:

As indicated in Section 4.4.1 equipment maintenance has up to WWII been the responsibility of individual craftsmen such as carpenters, smiths, coopers, wheelwrights and masons, repairing the buildings, primitive machines and vehicles of the day (Sherwin (2000). No evidence could thus be found of any dedicated maintenance organization structures or the application of any unique maintenance management organization design principles.

The establishment of the so-called maintenance department only took place towards the 1960's when the level of technical specialization within organizations required management to rethink their approach to maintenance management. These developments will be discussed in more detail in the next section.

4.4.2.2 The Bureaucratic Organization (1945–1990)

In order to assist the reader a short summary of developments in the field of general organizational design paradigms in the period 1945–1990, (as discussed in detail in Chapter 2), will firstly be provided. **General Organizational Design:**

> The post-war period was according to Weber (2009) characterized by the spread of a *"spirit of functional efficiency and measurement"*. As indicated in Section 2.3.2 the focus on rationalization has so dominated the thinking during this period that even though we saw the evolution of strategy models and paradigms the organizational archetypes have not really fundamentally changed or developed much in this time. When new organization forms were invented the process of rationalization forced it back to what Løwendahl & Revang (1998)) refer to as *"the iron cage of bureaucracy"*.
> Organizations were designed along functional lines and attempts were continuously made to clearly define tasks, jobs and positions. The relationships between those who occupied various jobs were also formalized as far as possible.

PAM Organizational Design:

The higher levels of organizational efficiency that characterized the post-war period was partly the result of far higher levels of mechanization and automation. The introduction of new equipment, machines and technology however required a different approach to maintenance strategy. Craftsmen and artisans no longer had enough general knowledge and skill to maintain all equipment.

In response to the strategic challenges that were posed by this reality organizations gradually started to delineate responsibility. This period saw the creation of an organization that was characterized by hierarchical structures and the formation of highly specialized departments. According to Tsang (2002) most asset intensive organization in this period had the following dedicated departments to:

- The **Engineering department** – responsible for the design and procurement of new plant as well as modification of existing ones;
- The **Production department** – responsible for operating the plant; and
- The **Maintenance department** – responsible for plant and equipment maintenance. During this period the maintenance workforce became more and more specialized and were organized into highly specialized trades, such as Boilermaker, Electricians, and Fitters and Turners.

It should be noted that most Asset Management organizations are still organized along these lines. Tsang (2002) is however of the opinion this type of organization design

often contribute to some of the strategy execution challenges faced by contemporary PAM practitioners. Typical problems that are caused by this design include the following:

- The formation of super specialized single trades has led to deskilling and the sub-optimal utilization of resources. The demarcation of trades and skill levels creates inflexibility which causes inefficiency in the planning and execution of maintenance works that involve multi-trade tasks. The implication is that Asset Management especially during non–peak production periods is often impossible due to the un-availability of competent artisans;
- The vertical and horizontal polarization that is a consequence of super specialization often prevent the free flow of communication and sharing of knowledge;
- It does not foster a sense of ownership of assets;
- The large number of hierarchical layers that typically characterize the Bureaucratic Organization require the employment of unnessesary managers that are very expensive;

These and other challenges will be elaborated on in Chapter 5. In the next section the focus will fall on the characteristics of contemporary AM Organizational Design principles and the way in which practitioners and academics attempt to optimize the PAM strategy execution process through the design of appropriate PA organizations.

4.4.2.3 The Contemporary Organization (1990–current)

In order to assist the reader a short summary of contemporary developments in the field of general organizational design paradigms (as discussed in detail in Chapter 2), will firstly be provided.

General Organizational Design:

In Section 2.2.3 it is noted that the challenge faced by contemporary organizations is no longer the definition of a grand plan, but rather the continuous generation of innovative and new ideas that would surprise and confound the competition and delight customers and potential customers. Within this context the building of outstanding, adaptive and agile capabilities should be the primary function of organizational design. The focus is thus no longer on control but rather coordination (Grant (2010)).
It was noted in Section 2.3.3 that Drucker (1994) was one of the first contributors to juxtapose de-skilling, a typical result of the Taylorist/Bureaucratic Organizational archetype, with continuous learning, a typical requirement within the post-industrial and Contemporary Organization. Ghezzi (2013) points out that rather than rationalization and super specialization, a contrary process came into play during the 1990's, where role occupants had to acquire more knowledge to be able to respond to fast changing circumstances. Each new discovery resulted in the expansion of knowledge and therefore greater options and more complexity.
Hage & Powers (1992) call this upward learning spiral *"complexification"*. One consequences of complexification is an increased emphasis on human capital. In contrast to the clear definition of the *"one best way"* (the aim of Scientific Management) there is a growing trend towards the empowerment, emancipation and engagement of organizational members at all levels of authority and responsibility. There is thus a realization that all level of workers has the ability to both think and do (Clegg *et al.* (1999)).
There is a clear move away from clearly defined job descriptions. Workers are able to occupy multiple roles and their responsibilities and authorities shift, depending on the role they play at any given point. The result is the formation of temporary hierarchies. Although the empowerment of organizational members sound intuitively positive, the resultant complexification in terms of control and co-ordination introduces a number of other management challenges (Mumby & Putnam (1992)).
The complexity, unpredictability, and instability of environmental change thus seem to have outpaced traditional organization design approaches and concepts. Executives are according to Worley & Lawler III (2010) struggling to design organizations that are efficient enough to drive performance in the short run and flexible enough to sustain performance over the long run. The new normal requires organizations to have an amazing amount of agility just to survive, let alone thrive.
Worley & Lawler III (2010) define Agility as:

> *"...a dynamic organization design capability that can sense the need for change from both internal and external sources, carry out those changes routinely, and sustain aboveaverage performance. The final characteristic (sustained above average performance), is the sine qua non of agility."*

The same holds true for PAM and the organization of the PAM function within the contemporary organization. In the next section contemporary developments within the PAM environment will be evaluated.

PAM Organizational Design:

It was illustrated in Section 4.4.1.2, that hierarchy and fractionated tasks (the result of specialization) are the design logic of Bureaucratic Organizations. Within this context workers are not expected to respond to unpredictable events. This design is suitable for stable environments, but are not conducive to work situations characterized by inherent uncertainties, as in the case with maintenance work. Contemporary PAM practitioners have to contend with the fact that failures might occur in multiple possible locations, and that the extent of damage caused by a failure might differ from failure to failure. In addition hereto PAM practitioners need to consider differing windows of opportunities available for disruptive work to be performed on the plant (Tsang (2002).

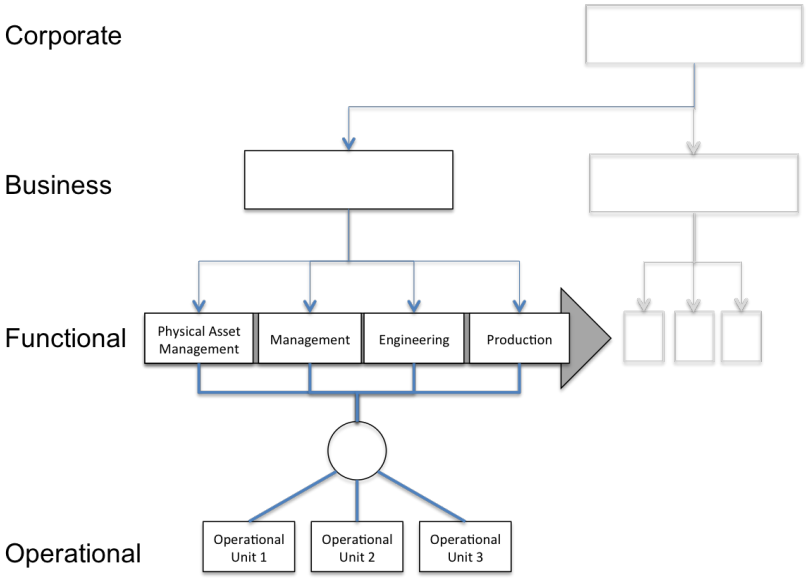
Mitchell *et al.* (2007) and Kellick (2010) point out that despite engineering skills, PAM practitioners also require competencies such as strategic management, human resource– and financial management. Stewart *et al.* (2003) are of the opinion that PAM should integrate different organizational and management levels. In their framework the aim to provide a coordinated agency-wide perspective on asset management. They recognize that the management of PA is vitally supported by processes, commercial tactics, information systems, data and knowledges as well as organizational and people practices.

In line with the views of Ghezzi (2013) and Hage & Powers (1992), Amadi-Echendu *et al.* (2010) agrue that PAM practitioners require a multi-faceted skills set to address the vexed issues in the field. In this regard they highlight five characteristics of a broader conceptualization of the PAM organization. Theses characteristics are shown in Table 4.5.

Table 4.5: Characteristics of a broader conceptualization of PAM

Asset Class	**Description**
Spatial Generality	PAM extends accross all types of assets, including human resources, in any industry.
Time Generality	PAM extends over time to include short term and long term aspects of physical assets.
Measurement Generality	Real and financial measurement dimensions: measurement data includes measures of economic value, social attributes as well as physical attributes of assets.
Statistical Generality	Risk and other higher moment estimates of measures are important in asset management as well as the basic, first moment return measure of asset performance.
Organizational Generality	PAM takes place at all levels of the organization from direct contact with the asset to the strategic interactions that take place in the boardroom. Figure 4.16 illustrates PAM within the context of the contemporary organization.

Figure 4.16: PAM within the context of the contemporary organization



Adapted from Amadi-Echendu et al. (2010)

In an effort to ensure higher levels of flexibility and AM organizational agility Tsang (2002) suggest the formation of so-called Self-Managing Teams (SMTs), which aim at leveraging and enhancing employees' capabilities. SMTs are commonly used in agriculture, mining, and construction.

Kolodny & Stjernberg (1993) proposed the following generic design principles for SMTs:

- Team activities should be task and performance focused;
- The team should be responsible for the completion of whole tasks;
- Administrative functions such as planning, regulation and evaluation should be under the control of the team as far as possible;
- The selection of new team members should be the responsibility of existing team members;
- The formalization of detailed task specifications, procedures and methods should be kept to the minimum. Only those essential for information required for sharing with other stakeholders are formalized.
- Group norms should be actively fostered and should govern the interaction between team members. Internal standards should be based on group norms. This flexibility

allows the team to evolve and change as members grow and develop, and increase their competencies through multi-skilling.

- Effective teams require access to multiple skills. The availability of a large skill set enables the team to quickly adapt and respond to planned changes as well as to unanticipated events.
- SMT's needs the autonomy to adjust and reorganize its internal resources, skills and competencies in response to the changed needs of its work.

Within the literature dealing with the issues involved in organizational team dynamics reference is made to various forms of self-managed teams. These teams are also referred to by various names including Centres of Excellence (COE) (De Giorgi & Pellizzari (2014), Adenfelt & Lagerström (2008)), Self Directed Work Teams (SDWT) (Van Amelsvoort & Benders (1996), McIntyre & Foti (2013)) and Empowered Teams (Tannenbaum *et al.* (2012)). It is not the purpose of this study to evaluate each one of these team formation types in detail, suffice to acknowledge that these formations exist and that they are deployed with great success within organizations facing contemporary strategic challenges.

In the next section the focus falls on the evolution of management control systems.

4.4.3 The evolution of Management Control Systems

In Section 2.4 the relationship between Organizational Design (discussed in Section 2.3 and the Management Control System (MCS)s within the organization was compared to the relationship that exists between computer hardware and software. OD provides the infrastructure, while MCSs provide the mechanisms of communication, decision making and control that allow organizations to solve the problems of coordination, cooperation and control (Grant (2010)).

Strategic– and Management Control Systems provide information that is intended to be useful to managers in performing their jobs and to assist organizations in developing and maintaining viable patterns of behaviour. For this reason Section 2.4 were dedicated to gain an understanding of general Strategy– and Management Control theory. In the next section the evolution of Strategic and Management Control design paradigms within the PAM context will be evaluated.

For the sake of comparison and consistency the time periods referred to in the Table 2.9 will also be used in this section.

4.4.3.1 The Modern Organization (1900–1945)

In order to assist the reader a short summary of developments in the field of MCSs in the period 1900–1945 (as discussed in detail in Chapter 2), will firstly be provided. **General**

MCS design principles:

As indicated in Section 2.4.3 Scientific Management principles assume that workers are of limited intelligence, innately idle and driven by the need for immediate gratification. Control Systems within the Modern Organization was thus developed to support these ideas. Management Control Mechanisms were relatively simple and theoretical contributions in this time mainly focused on the development of effective pay and reward systems.

PAM MCS design principles:

As indicated in Section 4.4.1 equipment maintenance has up to WWII been the responsibility of individual craftsmen (Sherwin (2000). No evidence could thus be found of any dedicated maintenance management control systems in this period.

4.4.3.2 The Bureaucratic Organization (1945–1990)

In order to assist the reader a short summary of developments in the field of MCS in the period 1945–1990 (as discussed in detail in Chapter 2), will firstly be provided. **General**

MCS design principles:

Robert Anthony (Anthony (1965)) was the first exponent to present a framework for Strategic– and Management Control. The Control Systems within the BO was however mainly focussed on:

- Providing accounting information;
- Individual responses to information; and
- The formulation of defensive strategies.

PAM MCS design principles:

PAM MCS developments within the BO should be seen against the backdrop of at least the following five important developments:

1. The formation of dedicated maintenance departments was a post war development and the exact nature, role and objectives of these departments were thus still relatively ill-defined during this period (see Section 4.4.2.2);
2. In line with the management principles promoted by Taylor and Weber a management and supervision layer was established in most organizations in this period.

The roles and responsibilities of this layer of management and supervision was however also ill-defined and role-players had to rely very strongly on command and control principles that were established during the war;

3. Robert Anthony's seminal work on Management Control was only published in 1965 (Anthony (1965)). Up to that point the focus of Management Control Systems was on the establishment of accounting systems and the development of accurate financial reporting mechanisms;

4. This period saw the proliferation of various computer aided systems; and

5. During this period the link between employee behaviour and, measurement and control, was for the first time specifically studied and described. The well-known phrase: *"What gets measured gets done"* was coined by Peters & Waterman (1982) during this period. Over the decades the phrase has become the mantra during most conversations on management control.

In line with the general strategic decision framework developed by Simon (1977) (see a detailed discussion in Section 2.4.6.1) it became in this period, possible to distinguish between three types of PAM decisions namely:

- **Strategic** – These decisions are made in the selection of design options for management systems or products to be developed, or plant and machinery to be acquired that will be compatible with the organizations business strategy.
- **Tactical** – These decisions relate to the formulation of policies for effective and efficient use of available resources.
- **Operational** – These decisions are made to achieve a high level of effectiveness and efficiency in maintenance activities.

The measures used during this period to evaluate PA performance however reflected the operational focus of the discipline at the time. This should be seen against the backdrop of the fact that strategy was not used explicitly as a variable in any MCS research until the 1980s (see Langfield-Smith (1997) and that the strategic importance of PAM was not recognized until the early 2000's.

Campbell & Reyes-Picknell (1995) for classified the PA performance measures that were commonly used during this period. They identified three performance measurement categories:

1. Measures of equipment performance - e.g. availability, reliability, and overall equipment effectiveness;

2. Measures of cost performance e.g. Operations and Maintenance (O&M) labour and material costs; and

3. Measures of process performance e.g. ratio of planned and unplanned work, schedule compliance.

These measures are according to Tsang (1998) diagnostic measures that only determine whether the maintenance function remains in control or compares favourably with its counterparts elsewhere within or outside the organization. They are mainly used to support operational control and to facilitate benchmarking. Most of these measures are also backward looking and introspective, with a strong bias on financial and process-related measures.

Tsang (1998) is furthermore of the opinion that these operationally focused measures lead to dysfunctional PAM behaviours. These behaviours typically include:

- Reducing training and development budgets for operator and asset management staff training;
- Cutting cost on equipment design modifications to achieve short term cost reduction goals, without considering the impact on potential long term savings that can be realized through higher levels of reliability; and
- Allocating longer than necessary turn–around time for shutdowns to ensure achievement of schedule compliance goals.

Although these performance measures were conceptualized during the Bureaucratic period they are still commonly used within the Contemporary Organization. The argument here is not that these measures are not important, but that they are often inappropriate for determining the contribution of PAM to the business success of the organization and that they potentially lead to non – strategic behaviour and decision making.

In the next section contemporary developments and contributions in the field of PAM MCSs will be evaluated.

4.4.3.3 The Contemporary Organization (1990–current)

In order to assist the reader a short summary of contemporary developments in the field of MCS (as discussed in detail in Chapter 2), will firstly be provided.

General MCS design principles:

A large variety of MCSs and artefacts are used within the Contemporary Organization. In line with the fact that the organizational landscape is in a state of continuous flux control systems also evolve on a continuous basis to assist managers and decision makers. The complexity of the contemporary business landscape makes the development of an "ideal" MCS impossible.

PAM MCS design principles:

Despite the fact that many PAM MCSs still have a very strong operational control focus a number of academics and practitioners have made contributions to the development of a PAM MCSs with a more strategic focus (Tsang (1998), Tsang (2002), Sherwin (2000), Thomas *et al.* (2008)).

Many of these contributors applied the theory and principles of the MCS artefacts introduced in Section 2.4.6. It is not the purpose of this section to repeat these theories and principles or to judge the quality of application to the PAM discipline. The aim here is to illustrate that academics and practitioners are:

- Contemplating the use of these MCS artefacts within the Contemporary PAM Organization; or
- Are indeed using them to assist organizations to execute their PAM strategies.

Tsang (1998) contends that Physical Asset Management Strategy (PAMS) is often formulated at senior management level and that it is often too abstract for line management to internalize. The Balanced Scorecard (BSC) is according to him a very useful strategy translation and alignment tool. The strategy is translated into long-run (strategic) objectives, the attainment of which is determined by appropriate performance measures with their related targets. Action plans are then formulated to achieve these strategic objectives. The use of this instrument also assist the organization to determine the cause–and–effect relationships between various objectives and between the action plans and the strategy[1].

The following example illustrates how the BSC can be applied to the maintenance operation of an urban railway system. The measures featured in the scorecard may according to Tsang (1998) include:

- Financial perspective: O&M costs per car-km;
- Customer perspective: Failure induced delays per 1,000 passenger journeys;
- Internal process perspective: Time for completing a major overhaul; and
- Learning and growth perspective: percentage of staff with cross-trade training.

By 2006 Garg & Deshmukh (2006a) was however still not convinced that the BSC was a feasible PAM MCS methodology and he called for further research in the area. He heeded his own call and published a paper in 2012 in which he explores the use of the BSC in multi–echelon repair inventory systems (Garg & Deshmukh (2012)). He concludes that

[1]See Section 2.4.6.4 and Section 4.2 for a detailed discussion of the BSC and the way in which the BSC assist organizational decision makers to map and understand asset co-operation, integration and interdependencies.

despite criticism, (such as the fact that cause and effect relationships between variables in the various perspectives are not illustrated well enough), the BSC seem to be one of the most widely used MCS methodologies within the asset management environment.

Thomas *et al.* (2008) applies a combination of Six Sigma ($6-\sigma$)[1] and Lean operating principles (LEAN)[2] within the context of Total Productive Maintenance (TPM). In their quest to reach $6-\sigma$ performance levels organizations normally apply the Define, Measure, Analyze, Improve and Control (DMAIC) methodology. The methodology consists of the following phase:

1. (D)efine. Who are the customers and what are their priorities? Where are their problems? Which do we tackle first?
2. (M)easure. How is the process measured and how is it performing? What is its current state of performance?
3. (A)nalyze. What are the most important causes of performance failure?
4. (I)mprove. How do we remove the causes of poor performance?
5. (C)ontrol. How can we embed and maintain the improvements made?

LEAN is according to Womack & Jones (1996), aimed at reducing waste and adding value to production systems so that systems performance is significantly improved and a company *"does more with less"*. The basic LEAN philosophy relies on a five phase approach:

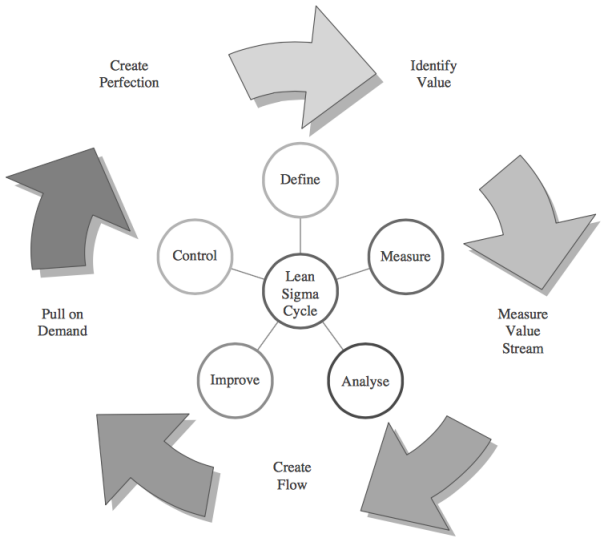
1. Identify value (from the point of the customer).
2. Measure the value stream.
3. Pull on customer demand.
4. Create flow.
5. Achieve perfection.

Figure 4.17, illustrates how a combination of LEAN and $6-\sigma$ principles can be applied to ensure the effective implementation of TPM. Thomas *et al.* (2008) calls this approach LEAN Six Sigma (LSS). The main main phases of the integrated LSS approach are:

[1] See a detailed discussion on the basic principles and business application of $6-\sigma$ in Section 2.4.6.5.

[2] The ideas of lean thinking were originally developed within the Toyota Manufacturing System. Womack & Jones (1996) were the first authors to apply the LEAN principles beyond manufacturing. The ideas of LEAN thinking comprise a complex mixture of ideas including continuous improvement, flattened organization structures, teamwork, elimination of waste, efficient use of resources and cooperative supply chain management.

Figure 4.17: LSS within the context of Total Productive Maintenance (TPM)



Adapted from Thomas et al. (2008)

1. Define what is the problem? Does it exist?;
2. Measure how is the process measured? How is it performing?;
3. Analyze what are the most important causes of defects?;
4. Improve how do we remove the causes of the defects?;
5. Control how can we maintain the improvements?;
6. Implement 5S technique[1];
7. Application of Value Stream Mapping (VSM);
8. Redesign to remove waste and improve value stream;
9. Redesign manufacturing system to achieve Single Unit Flow (SUF); and
10. Apply TPM to support manufacturing.

It is not the purpose of this section to provide an comprehensive literature review on contemporary PAM MCSs, suffice to conclude that a large variety of Management Control

[1]The application of the 5S technique produces a workplace thats clean, uncluttered, safe and organized. The 5S's stand for 5 Japanese words that constitute good housekeeping. Roughly translated they are: Sort (Seiri), Set in order (Seiton), Shine (Seiso), Standardize (Seiketsu) and Sustain (Shitsuke).

Systems and artefacts are used within the contemporary organization. Academics and practitioners are continuously applying these principles to the field of PAM. In the light of the fact that the PAM landscape is however in a state of flux it is not surprising that PAM MCSs are in a continuous state of evolvement. To ensure the achievement of strategic, tactical as well as operational PAM goals, the PAM MCS however need to be far more inclusive and the performance measures should be linked to the strategy of the PAM function and the PAM MCS should be linked to the strategy of the organization in order to get the maximum impact.

4.5 Vital learnings and conclusion

The first objective of this chapter was to present an organizational asset classification framework and to illustrate the co-operation and interdependencies between various asset classes. The classification of organizational asset proved to be more complicated than anticipated. The literature review however highlighted three important aspects:

- There seem to be no comprehensive and generally accepted organizational asset classification framework, the framework presented in Section 4.1 is not an attempt to fill this gap, but was merely presented to provide a reference point for the purpose of this study;
- There seem to be no consistent way in which the value contribution of various organizational assets classes are reported on. Physical Assets are for example reflected on the organizational balance sheet, while intangible assets such as technology, reputation and culture are not reflected on the balance sheet;
- Contributors seem to accept that Strategy Execution is strongly influenced by the interdependencies and co-operation between various asset classes. For this reason it is important to understand and map these interdependencies. There however seem to be no generally accepted model to map and illustrate these interdependencies. The BSC and more specifically Strategy Maps seem to be the most widely used instrument. Although Strategy Maps seem to be useful for mapping direct dependencies, critics are however sceptical about the effectiveness of strategy maps to also map indirect dependencies. These critics argue that the indirect dependencies should be mapped through the development of so-called Value Creation Maps (VCMs).

The second objective of this chapter was to provide a brief overview of recent developments within the PAM landscape. The literature review highlighted the following important aspects:

- Over the past decade the PAM landscape has changed dramatically. The most important implication of these changes seem to be a realization among academics

and practitioners that PAM requires an integrated approach that joins bordering disciplines. The collective recognition among PAM stakeholders for the need for optimizing the mix of cost, risk and performance over the assets entire life cycle and to do so in a governable and sustainable manner, seem to be the biggest catalyst for the changes in the landscape;

- The recognition for the need to change led to a number of attempts in the last decade to standardize the field. These attempts led to the all important publication of the ISO 55000 standard in 2014. ISO 55000 is the the first set of international standards for asset management;

- In addition to the ISO 55000 standards the Institute for Asset Management (IAM) described the overall scope of AM. The IAM model identifies six AM subject groups. The model also highlights the fact that AM is about the integration of these groups of activities and not just the activities in isolation. Despite the fact that the IAM identifies six subject groups, an analysis of AM literature illustrates that the vast majority of contemporary contributions deals with issues regarding the management of the Asset Management Life Cycle (AMLC).

The third and most important objective of this chapter was to evaluate PAM strategy developments over the past 100 years, within the context of the organization strategy and within the context of contemporary strategy discourse. The literature review highlighted the following important aspects:

Petrov & Rowe (1997)

- There is a very strong correlation between developments within general business and strategy management discourse and the developments within the PAM discourse. Contributors within the PAM discipline however seem to be reactive and typically do not dictate the strategy management agenda. Perceptions regarding the role of PAM has evolved from *"necessary evil"* in the 1940s to *"positive cooperation"* post 2000. The evolution should however been seen as a reaction to developments within the business world;

- Prior to 2000 there is very little on no reference to PAM *per se*. Most if not all literature in the period 1940–2000 referred to maintenance management. Any reference to maintenance management prior to 2000 was for the purpose of analysis regarded as reference to PAM;

- The dominant strategy discourse of the late 1980's and early 1990's revolved around the *"resource based view of the firm"*. This view had a major impact on the way in which organizations approached the formulation of strategy. Up to this point conventional approaches to competitive advantage focused upon so-called generic sources of competitive advantage – namely cost and differentiation advantage. The contention was thus that organization perform better and create more value when

they implement strategies that are responsive to market conditions. Exponents of the resource based view of the firm contended that the firm itself, in terms of its resources an capabilities may be a far more sustainable basis to define strategy. It is thus no co–incidence that perceptions regarding PAM evolved in this period from *"technical specialization"* to *"profit contributor"*.

- There is also strong correlation between Organizational Design principles within the PAM discipline and general Organizational Design principles. In this regard it is noteworthy that some progressive PAM contributors for example recommend the implementation of agile organization design principles. These principles include multi-skilling, the implementation of Self Managed Teams and Centres of Excellence. The reality however is that most PAM organizations still seem to embrace Bureaucratic Organization design principles based on the ideas of Taylor and Weber;

- Strategic– and Management Control Systems provide information that is intended to be useful to managers in performing their jobs and to assist organizations in developing and maintaining viable patterns of behaviour. The literature review confirms that a large variety of management control systems and artefacts are used within the contemporary organization. Contributors are also continuously applying these principles to the field of PAM. To ensure the achievement of strategic, tactical as well as operational PAM goals, the PAM MCS however need to be far more inclusive and the performance measures should be linked to the strategy of the PAM function and the PAM MCS should be linked to the strategy of the organization in order to get the maximum impact.

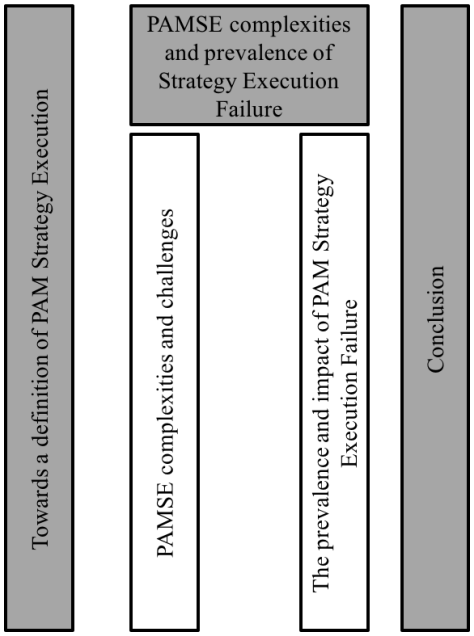
In Section 2.5 it was concluded that many of the developments in the application of strategy is the result of changes in the very nature of competition and operations between and within businesses. It was thus illustrated that the relationship between strategy theory development and business operation is clearly Hegelian in nature. It was however also pointed out that it was sometimes difficult to identify if changes in strategy management theory patterns is the result of changes in the nature of business or vice versa. The literature review of PAM strategy developments however clearly illustrate that PAM strategy development seem to be far more reactive and that PAM strategy contributors typically do not dictate the strategy management agenda.

The next Chapter is dedicated to a literature review of contributions on PAM Strategy Execution challenges.

Chapter 5

Physical Asset Management Strategy Execution

Figure 5.1: Chapter 5 Outline



The complexities involved in the formulation of organizational strategy was illustrated in Chapter 2, and in Chapter 3, where it was illustrated that the execution of strategy is often even more complex than strategy formulation. In Chapter 4, Physical Asset Management Strategy (PAMS) developments were evaluated within the context of the organizational strategy and contemporary strategy discourse. In Chapter 5 the focus will fall on Physical Asset Management Strategy Execution (PAMSE) contributions and practices.

It is at the outset of this chapter however again important to note that the relatively large body of knowledge on the topic of Strategy Control (SC) referred to in Section 2.4.5 and PAM SC referred to in Section 4.4.3 should not be confused with Strategy Execution. Strategy Control Systems provide important feedback mechanisms (mostly after the fact) regarding the effectiveness of strategy.

During the evaluation of the literature on SEF the maturity models developed by the IAM (2011) and Volkers et.al. (2011) group were also specifically considered. The conclusion reached was however that although these models are extremely important they however do not assist the organization in the early detection and prevention of Strategy Execution Failure.

In Chapter 3, it was noted that up to the start of the contemporary strategy management period very little cohesive research has been done on the topic of Strategy Execution. In line with the conclusion drawn in Chapter 4 that PAMS seems to be reactive and that PAM contributors do not dictate the strategy discourse agenda, it is not surprising to find very few publications dealing specifically with the challenges involved in PAM Strategy Execution.

Baum & Vlok (2013) confirm this and according to them the topic of Strategy Execution is largely disregarded in the field of PAM and most PAM publications do not attempt to thoroughly discuss Strategy Execution. They contend that an enormous gap exists in the Physical Asset Management Body of Knowledge (PAMBOK) as most publications on PAM tend to focus on aspects such as asset life cycle activities, advancing new methodologies for planning and assessment, and asset optimization. These contributions were evaluated in detail in Chapter 4.

Despite the disregard for PAMSE within academic discourse the consequences of PAM Strategy Execution Failure (SEF) is however widely published in both main stream media and academic journals and will be referred to in this chapter.

The objectives of this chapter is to:

- Define Physical Asset Management Strategy Execution (PAMSE) and by implication PAM Strategy Execution Failure;
- Analyze the recent main stream, empirical and theoretical contributions regarding PAMSE and SEF; and
- Discuss the limitations and shortcomings of the existing PAM Strategy Execution Body of Knowledge (SEBOK).

A review of the literature reveals no generally accepted definition of PAM Strategy Execution. In the next section the concept will be defined and contextualized.

5.1 Towards a definition for PAM Strategy Execution

In the quest to find an acceptable definition for Strategy Execution (see complete discussion in Section 3.1), fundamental questions regarding the correlations between organizational performance and Strategy Execution were raised.

It was pointed out by Miller (1997) as well as Dean & Sharfman (1996) that corporate performance is not necessarily and indication of successful SE. These authors were furthermore of the contention that it was vitally important to, in the presence or absence of good corporate performance understand the functioning and relationship between the various elements of strategy.

In the absence of a generally accepted definition of PAM Strategy Execution the following three definitions distilled and referred to prior in this document will be used in the formulation of a definition for PAM Strategy Execution.

- The definition of Contemporary Physical Asset Management (CPAM) defined in Section 4.3.1;
- The definition of Physical Asset Management Strategy defined in Section 4.4.1.3; and
- The definition of Strategy Execution defined in Section 3.1.

In Section 4.3.1 a contemporary definition for Physical Asset Management have been distilled and is repeated here for ease of reference:

> *"CPAM is a strategic process aimed to ensure that PA contribute to the creation of sustainable competitive advantage. It requires an in–depth understanding of all organizational asset types, (tangible, intangible and human) their associated capabilities and risks, as well as the direct and indirect interrelationship and interdependencies between these asset types. CPAM is a multi-disciplinary process and requires involvement from stakeholders across organization to not only identify potential barriers and silo's but to actively break these silo's and barriers down."*

The contributions of a number of researchers were considered prior to the formulation of this definition. These included PAS-55 (2010); ISO (2014) and Mitchell & Carlson (2001). These contributions will not be repeated again in this section.

In Section 4.4.1.3 it was noted that the Institute for Asset Management (IAM), defines Physical Asset Management Strategy (PAMS) as follows:

> *"Long term optimized approach to the management of assets, derived from, and consistent with the organizational strategic plan and the asset management policy (IAM (2011))"*

In Section 3.1 the following definition for SE was distilled:

SE refers to the continuous process during which an organization critically evaluates and adjusts:

- The applicability of its organizational design and management systems (including control mechanisms); and
- The readiness of its interpersonal processes such as strategic consensus, behaviours, organizational climate and communication,

In order to ensure the acceptable completion, achievement and stakeholder acceptance of strategic objectives.

The contributions of a number of researchers were considered prior to the formulation of this definition. These included contributions from Miller (1997); Hrebiniak (2008); Li *et al.* (2008); Noble (1999b) and Crittenden & Crittenden (2008). These contributions will not be repeated again in this section.

In the only peer reviewed article that could be found, dedicated to the topic of PAMSE, the authors Baum & Vlok (2013) defined PAMSE as follows:

> *"It is the the process of translating the Physical Asset Management Strategy aspirations into workable actions, and of managing strategic initiatives through the allocation of resources and the coordination of responsibilities and accountabilities, while continuously reviewing, adapting, and communicating this process."*

The definition by Baum & Vlok (2013), is indeed useful but in the light of the insights gained during the literature review that formed part of this study the above definition will be extended and for the purpose of this study, Physical Asset Management Strategy Execution (PAMSE) will have the following definition:

PAMSE refers to the continuous process during which an organization critically evaluates and adjusts:

- The applicability of its Physical Asset Management Strategy relative to the Organizational Strategic Plan;
- The applicability of the PAM organizational design and management systems (including control mechanisms); and
- The readiness of its interpersonal processes (such as strategic consensus, behaviours, organizational climate and communication),

in order to ensure that PAs contribute to the creation of sustainable competitive advantage.

5.2 PAMSE complexities and prevalence of Strategy Execution Failure

As indicated above no peer reviewed publications apart from Baum & Vlok (2013), could be found dealing specifically with the topic of PAMSE. During the review process the following literature databases were interrogated:

- Ebscohost;
- Elsevier;
- ProQuest ABI;
- Emerald;
- Sciencedirect; and
- JSTOR.

During the review the following search criteria were used:

1. The following search terms were used "PAM Strategy Execution", "PAM Strategy Implementation"; "Maintenance Strategy Execution"; and "Maintenance Strategy Implementation";
2. As a result of the limited publications that were found using these search terms, the search was extended by referring to the references sections of the previously retrieved articles on both PAMS and SE. Atricles which treat SE or SI as one of the major subjects even if their title or keywords did not include the terms were thus also considered.

3. Finally these articles were evaluated to confirm whether they explicitly discuss factors impeding or enabling SE success.

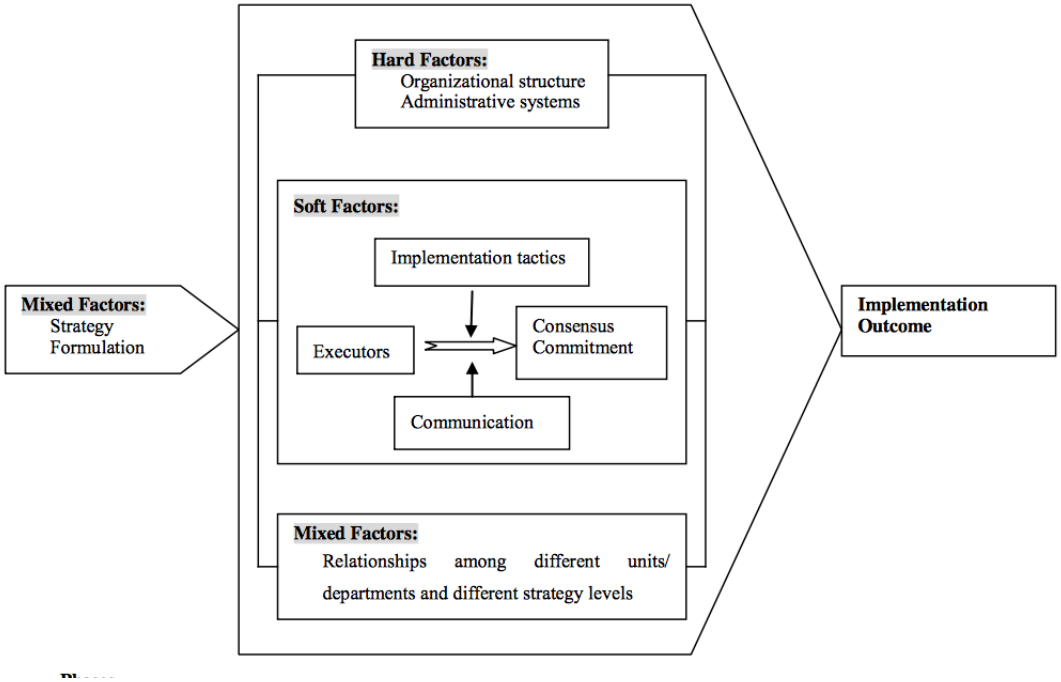
The extended search also did not reveal any meaningful results. Some authors (e.g. Amadi-Echendu *et al.* (2010); Mitchell *et al.* (2007); Woodhouse (1997); Mitchell & Carlson (2001); and Schuman & Brent (2005)), did refer to the complexities involved in the PAMS formulation process and to some extend to the impact PAM SEF has on organizational sustainability. These contributions will be evaluated in more detail in Section 5.2.1. No **dedicated** studies on the factors influencing PAM SEF, or on possible models ensuring the prevention of SEF could however be found.

The search was then extended further to include main stream publications and media. The methodology discussed above was repeated during this search process. This search revealed the following results:

- A number of governmental guidelines have been published in recent years to assist practitioners in the PAM process. These include:
  - The *"Transportation Asset Management Guide - A Focus on Implementation"*, published by the American Association of State Highway and Transportation Officials in 2015 (AASHTO (2015)); and
  - The *"Asset Management Policy: Implementation Standard for Asset Management"*, published by the Queensland Health Authority in Australia in 2012 (QHA (2012)).
- A number of internal publications and white papers by consulting firms specializing in the field of PAM;
  - *"Pragmatic Implementation of PAS 55"*, by Grahame Fogel of the consulting firm Gausian in 2013 (Fogel (2013)); and
  - *"Mine The Growing Disconnect"*, publication by PWC in 2012. (PWC (2012)).
- A number of articles published in online as well as printed industry publications such as:
  - *"The Five Biggest Risks to Effective Asset Management"*, by Carl March and published in the publication Life Cycle Engineering in 2010 (March (2010)); and
  - *"Monitoring Asset Management Strategy Execution with KPIs"*, by Will McNett, in the publication Life Cycle Engineering in 2015 (McNett (2015)).

In the light of the fact that these contributions were not peer reviewed their content will not be analyzed in this section. The content of these contributions are however taken cognisance of and used in the development of the text in this chapter.

Figure 5.2: Nine recurring factors influencing Strategy Implementation



Reproduced from Yang et al. (2009).

5.2.1 PAMSE complexities and challenges

In the absence of a peer reviewed framework categorizing the factors impacting on successful PAMSE, the framework developed by Yang *et al.* (2009) and discussed in detail in Chapter 3 will be used to structure the discussion on PAMSE complexities and challenges. In this framework the most important recurring factors influencing SE were discussed.

These nine factors are depicted in Figure 3.2, and again here in Figure 5.2 for ease of reference. The discussion on these factors were concluded by expressing the temptation to develop yet another framework, especially in the light of the fact that factors mentioned by a number of SE contributors were not included in the framework. These factors included:

- Organizational culture;
- Firm size;
- The external or general market environment;
- Power structures; and

- Reward and recognition systems,

The development of yet another framework is however not the purpose of this study. Identification of all these factors are important and their validity accepted. It is furthermore strongly recommended that future research should focus on uncovering of even more of these factors. The objective of this study is however to develop a model that will assist academics and practitioners with the early detection and prevention of PAM SEF. The application and use of the model might in addition to a number of other steps discussed in detail in Chapter 6 require iteration and modification of these factors and derivates or combinations of these factors might be included in a context specific application. For the purpose of this study these nine factors will however be regarded as the most critical contributors to Strategy Execution Failure.

Despite the fact that PAMSE is largely disregarded in academic discourse, PAM contributors have commented on the complexities and challenges involved in PAM in general. Before these nine factors are contextualized, some of the general contributions made on the complexities and challenges involved in PAMSE will be referred to.

Amadi-Echendu *et al.* (2010) identify three characteristics of PAM that potentially has an impact on PAMSE:

These are:

- PAM is multidisciplinary since it requires the input of skills from virtually any discipline, such as engineering, information technology, economic and management;
- Decisions in PAM extend from strategic to operational and tactic aspects; and
- The human dimension of PAM requires the use of qualitative and more traditional quantitative modes of analysis.

Mitchell *et al.* (2007) identify to the following barriers to successful PAM:

- Management, organizational control and trust consistent with stated objectives of empowerment, ownership, responsibility and accountability;
- Partnership between maintenance and production;
- Full acceptance, buy-in for the PAM program at all levels of the organization;
- Full appreciation for the holistic, fully integrated processes, systems and organization necessary;
- Good communication and removal of institutional and organizational barriers to teamwork and coordination.

Finally in the only study up to date that is dedicated to the identification of the primary constraints involved in PAMSE Baum & Vlok (2013) mapped three primary constraints:

- Overloaded key actors – refers to the fact that decision making authority is centralized in one or two key stakeholders. This reality not only stifles quick and effective decision making, it also prevents skill transfer and often lead to stakeholders burnout;
- Collaborative breakdowns – refer to the lack of cross departmental collaboration and interaction;
- Excessive intra-departmental cohesion – refers to the fact that PAM practitioners in the absence of cross departmental collaboration, often tend to become extremely self-reliant and work in very close collaboration with departmental peers. This result in the maintenance of silo's and the problems related to collaborative breakdowns are thus further perpetuated.

When these characteristics, barriers and constraints are considered within the context of the observations made in Chapter 3, and the nine factors referred to in Figure 5.2, the following becomes apparent:

1. Although no contributions could be found referring specifically to the importance of strategy formulation within the context of PAMSE, many PAM contributors and publications refer to the importance of PAMS. These include ISO (2014); PAS-55 (2004); PAS-55 (2010); IAM (2011); Mitchell *et al.* (2007); Tsang (2009); Woodhouse (2006); Amadi-Echendu *et al.* (2010) and Baum & Vlok (2013) to name a few. These contributors and publications all agree that the PAMS is a the core of all PAM activities and that it should be aligned with the oganizational strategy and objectives.
2. Cross departmental relations has been identified in Section 3.2.1 as an important individual factor influencing Strategy Execution and the following three aspect identified by Chimhanzi (2004) and Chimhanzi & Morgan (2005) should be considered specifically:
    - Within the context of the contemporary organization agile teams with high level of autonomy seem to be more effective;
    - Unit autonomy without alignment seem to be a recipe for conflict and will have a detrimental impact on SE; and
    - Control and reward systems should facilitate the elimination of conflict of interest and the break down of cross departmental silo's.

3. The impact communication has on SE has been emphasized in a number of studies (see Alexander (1985); Rapert *et al.* (2002); Foreman & Argenti (2005) and Kellermanns *et al.* (2005)). These studies confirm that organizations where employees have easy access to management through open and supportive communication tend to outperform those with communication environments that are less effective.

   The multi-disciplinary nature of PAM implies that a multitude of role-player are involved in the process. As the number of role-players within any given context increase the probability of mis-communication increase as well. In addition hereto PAM decisions extend from strategic to operational and tactical. The PAM audience thus include role-players from accross the organizational spectrum and this increases the complexities involved in the formulation of the strategic message as well as the choice of communication media.

   In this regard PAS-55 (2004), also advised on the importance of effective communication and information sharing and the fact that practitioners need to ensure that all relevant stakeholder understood the message.

   Baum & Vlok (2013) is of the contention that information exchange is the bottom-line to align and co-ordinate the action of different departments to overcome resistance to change and silo-effects. Not only across functions but along the organizational hierarchy.

   Fogel (2013) agrees and argue that the fact that people don't understand the PAMS is one of the major obstacles to successful execution and he acknowledges that generally, communication problems exists within the PAM environment.

4. A number of studies conclude that executors of strategy (i.e. the people responsible for the execution of strategy that typically include top management, middle management, junior management as well as non-management staff), has a very important impact on SE success. Mitchell *et al.* (2007) seem to concur with this finding and Woodhouse (1997) is of the opinion that successful PAM can only be achieved through the clear alignment of top-down managerial direction and bottom-up delivery capabilities, leveraging the enablers of human factors. It is thus important that PAM practitioners should take cognisance of the theories and viewpoints on the role of strategy executors. These include the Strategy-Style Matching Theory (SSMT) first proposed by Slater (1989) as well as the studies done by Walderseel & Sheather (1996) and Wooldridge & Floyd (1990). These contributions were discussed in detail in Section 3.2.1, and will not be repeated here.

5. Floyd & Wooldridge (1997) refer to the importance strong strategic consensus and shared understanding and Dooley *et al.* (2000) reported that teams that had a shared understanding of priorities were far more succesfsul at executing decisions. No specific reference to the importance of strategic consensus within the general PAM literature could be found. This should however not be interpreted as an indication of the fact the PAM contributors disregard the importance of a shared understanding or consensus.

6. In line with the finding by Floyd & Wooldridge (1992) regarding the importance of strategic consensus, Mitchell *et al.* (2007) also refer to the importance of acceptance and buy-in by all stakeholder groups of the PAMS.

7. A number of studies refer to the effect Implementation Tactics (IT) and Change Management Tactics (CMT) has on the SE process (see Nutt (1986); Nutt (1999); Sashittal & Wilemon (1996) and Akan *et al.* (2006)). The conclusion reached by most of these studies is that the employment of CMT should not be done in isolation and practitioners should consider factors such as organizational culture, the extent of change and the characteristics of the role-players involved, when designing a change management campaign.

8. The importance of organizational design is referred to by a number of PAM contributors and publications. The IAM (2011) identifies Organizational Design (OD) and People Enablers as one of the six AM subject groups (see detailed discussion in Section 4.3.5. In their evaluation of Mitchell *et al.* (2007) and Kellick (2010) include the importance of PAM practitioners knowledge and skills. They point out that despite engineering skills PAM practitioners also require competencies such as strategic management, human resource and financial management. Stewart *et al.* (2003) are of the opinion the PAM should integrate different organizational and management levels. In an effort to ensure higher levels of flexibility and PAM organizational agility Tsang (2002) in the final instance suggest the formation of so-called Self-Managed Team (ST). These issues were however discussed in detail in Section 4.4.2.3 and the discussions will not be repeated in this section. Suffice to conclude that despite the fact that PAM contributors does not refer specifically to OD within the context of PAMSE, they do acknowledge the importance of OD within the context of PAM.

9. At the outset of this chapter it was reiterated that the relatively large body of knowledge on the topic of Strategy Control (SC) referred to in Section 2.4.5 and PAM SC referred to in Section 4.4.3 should not be confused with Strategy Execution. Strategy Control Systems and Management Control Systems provide important information that is intended to be useful to managers in performing their jobs. The general literature review on PAM confirms that a large variety of management control systems and artefacts are used within the contemporary organization. The importance of these systems have been evaluated in detail in Section 2.4 and in Section 4.4.3.3 and will not be repeated here. Suffice to note that the development and maintenance of apropriate SCSs and MCS is an essential aspect to consider during the PAMSE process.

Despite the fact that very few peer reviewed publications dealing specifically with the challenges involved in PAMSE could be found it is important to note that there is strong coherence between the findings and recommendations made in other peer reviewed literature on PAM, and findings made on SE in general (discussed in detail in Chapter 3).

In the next section the focus will fall on a number of recent examples of PAM SEF.

5.2.2 The prevalence and impact of PAM Strategy Execution Failure

It would be possible to discuss an infinite list of examples to illustrate the prevalence and impact PAM Strategy Execution Failure can have on people, organizations and even total economies. It is however not the purpose of this study to compile or evaluate such a list. In this section the focus will fall on three recent examples that were reported on widely in both international and national media and the impact of which were felt by large numbers stakeholders many of them outside the boundaries of the mentioned organizations.

For ease of reference the definition of PAMSE formulated in Section 5.1 will be repeated here.

> PAMSE refers to the continuous process during which an organization critically evaluates and adjusts:
>
> - The applicability of its Physical Asset Management Strategy relative to the Organizational Strategic Plan;
> - The applicability of the PAM organizational design and management systems (including control mechanisms); and
> - The readiness of its interpersonal processes (such as strategic consensus, behaviours, organizational climate and communication),
>
> in order to ensure that PAs contribute to the creation of sustainable competitive advantage.

Closer scrutiny of the definition will highlight the fact that the definition consists of four components or requirements.

- Part one refers to the importance of alignment between the PAMS and the OSP;
- Part two refers to the importance of Organizational Design and by implication also the availability of the right skills and competence as well as the availability and applicability of Strategy Control System and Management Control Systems.
- Part three refers to interpersonal readiness; and
- Part four refers to the fact that PAs should contribute to the creation of sustainable competitive advantage.

In order to assist in the evaluation of the below mentioned examples the scorecard depicted in Table 5.1 was developed. The scorecard is base on the four components of the PAMSE definition. Successful SE requires that the organization successfully meet the requirements of each one of the scorecard criteria. It is important to note that the suggestion here is not that this scorecard is the most comprehensive and effective tool to evaluate the successful execution of PAMS. It is merely an aid to assist in the evaluation of the mentioned examples. The scorecard will be developed further in Chapter 6, and could be used in conjunction with the model for the early dection and prevention of PAM SEF.

Table 5.1: Scorecard for the evaluation of successful PAMSE

Execution criteria	**Evaluation**	**Pass/Fail**
Part 1: Strategic Alignment		
Part 2: Applicability of Organizational Design management systems		
Part 3: Readiness of interpersonal processes		
Part 4: Contribution of PAs to sustainable competitive advantage		

5.2.2.1 The Deepwater Horizen oil spill disaster

Background: On the evening of 20 April 2010, a gas release and subsequent explosion occurred on the Deepwater Horizon oil rig working on the Macondo exploration well for BP in the Gulf of Mexico. Eleven people died as a result of the accident and others were injured.

The investigation into the disaster took many years and there are clearly a number of factors that have contributed to the disaster. Like any project of this scale a number of stakeholders involved. At the time of the accident the following three stakeholders were the most important. The rig was owned by Transoceans who was also mainly responsible for the maintenance of the rig (and more specifically the so-called Blowout Preventer (BOP). British Petroleum (BP) was the owner of the project and Haliburton was responsible for the cement plug that had to seal the well once completed. After analysing a number of publications, including articles in main stream media (see Alazraki (2010); McNulty (2010); Achenbach & Hilzenrath (2010); Gold & Casselman (2010) and Buchanan (2013)) the following recurring factors were identified as the most important contributors to the disaster:

- No culture of safety on the rig (Gold & Casselman (2010) and Achenbach & Hilzenrath (2010));
- Non–adherence to standard procedures – during testimony employees confirmed that BP sent the rig employees a request for a change in a key safety pressure test. That request, according to employees: *"...unorthodox and left crew members confused..."* (McNulty (2010);
- Unclear communication regarding the reasons for changing the safety pressure test (McNulty (2010) and Buchanan (2013));
- BP ignored the advice from Haliburton regarding the methodology used to plug the well (Gold & Casselman (2010) and McNulty (2010)) ;
- Key managers were absent when critical decisions had to be taken;
- Crew members ignored a number of warning signals from the MCSs on the day of the disaster;
- Investigation resulted in finger pointing between various stakeholder groups, and the implication is that roles and responsibilities were not clearly defined (Alazraki (2010)) ;
- According to testimony given by safety experts there were up to 222 overdue maintenance tasks on the Deepwater Horizon on the day of the disaster, and prosecutors blamed Transoceans that they had a "run to fail" policy in place for the Deepwater Horizon. This was denied by Transoceans executives (Buchanan (2013); and
- Transocean (one of the numerous sub-contracted service providers on board the rig) did not comply with recertification maintenance rules for the Deepwater Horizon's BOP. According to testimony the rig's BOP was designed to shut of the well in case of emergency, was four years overdue for major maintenance (Buchanan (2013) and Alazraki (2010)).

The evaluation of the Deepwater Horizen disaster: In Table 5.2 the Deepwater Horizen disaster is evaluated against the criteria determined for the evaluation of successful PAMSE.

Table 5.2: Evaluation of the Deepwater Horizen disaster

Execution criteria	**Evaluation**	**Pass/Fail**
Part 1: Strategic Alignment	BP's OSP placed a huge emphasis on safety and Transoceans executives testified that it was not the companies policy or intention to "run the rig to failure". Although there are strong evidence that there were non-adherence to protocols, and incorrect decision making, the superficial evaluation done here does not point to any significant strategy misalignment between the major role-players or between the OSPs of the various major stakeholders and the executors on the rig.	Pass
Part 2: Applicability of Organizational Design and management systems	As can be deducted from the above background there were a number of role-players involved in the project. This is not uncommon for projects of this scale, but it does seem that the roles and responsibilities of all stakeholders were not that clearly defined. This is specifically evident from testimony on the methodology used for the development of the cement plug. Haliburton staff claimed that recommendations were made that were not followed by BP. BP counter claims that Haliburton should not have continued with the job if they were of the opinion that these recommendations were so important. The analysis furthermore indicate that the MCSs did indeed indicate irregularities on the day of the disaster but that employees chose to ignore these warnings. Finally it became evident that a number of key decision makers were not on the rig at the time of the accident. This is a clear indication of management system failure.	Fail
Part 3: Readiness of interpersonal processes	Despite the fact that a detail retrospective analysis of the interpersonal processes that were in place on the rig at the time of the disaster is not possible, employees did indicate during testimony that there was no culture of safety on the rig. In the absence of a detailed assessment on the state of interpersonal processes within the organization, the management team will get the benefit of the doubt, and it will be accepted that the interpersonal processes were condusive to the successful execution of strategy.	Pass

Execution criteria	Evaluation	Pass/Fail
Part 4: Contribution of PAs to sustainable competitive advantage	If the comments made by Transocean executives that the organization did not have a "run to fail" are accepted, executors on the rig clearly disregarded the PAMS if there were up to 222 outstanding maintenance jobs on the day of the disaster and if maintenance on the BOP was neglected for more than four years. These facts seem to be the biggest indication of the fact that PAM SEF has occurred on the Deepwater Horizon.	Fail

The long term consequences: At its peak in 2010, the response effort involved the mobilization of approximately 48,000 people, the coordination of approximately 6,500 vessels and the deployment of approximately 1 500 kms of boom to contain or absorb the oil. As at the end of December 2014, BP has spent more than $14 billion and workers have devoted more than 70 million personnel hours on response and clean-up activities. The US Coast Guard ended the remaining active clean-up operations in the Deepwater Horizon area of response in April 2014. If residual oil from the Deepwater Horizon incident is later identified and requires removal, BP will take action at the direction of the Coast Guard. BP shares have more than halved after the Deepwater Horizon disaster.

In the next example the oil spills in the Niger Delta will be evaluated.

5.2.2.2 The Niger Delta oil spills with specific reference to the Seibou oil well

Background: The Niger Delta (ND) is an enormous classic distributary system, which stretches more than 300 kms wide and serves to capture most of the heavy silt load carried by the Niger River. The peak discharge at the mouth is around 21 800 m^3 per second in mid–October. According to Hogan (2013) the ND covers 20 000 km^2 within wetlands of 70 000 km^2 formed primarily by sediment deposition. The area is home to 20 million people and 40 different ethnic groups. The area makes up 7.5% of Nigeria's total land mass. It is the largest wetland in the world and maintains the third–largest drainage basin in Africa. The Delta's environment can be broken down into four ecological zones: coastal barrier islands, mangrove swamp forests, freshwater swamps, and lowland rainforests

According to Hogan (2013) the ecosystem contains one of the highest concentrations of biodiversity on the planet, in addition to supporting abundant flora and fauna, arable terrain that can sustain a wide variety of crops, lumber or agricultural trees, and more species of freshwater fish than any ecosystem in West Africa. The region could however experience a loss of 40% of its inhabitable terrain in the next thirty years as a result of extensive dam construction in the region as well as the carelessness of the oil industry.

Amnesty International reports that 550 oil spills occurred in the Niger Delta in 2014. By contrast, on average, there were only 10 spills a year across the whole of Europe between 1971 and 2011 (Amnesty-International (2015)).

A classical example hereof is the oil spills from the Seibou oil well, reported on for the first time on 23 January 2015. The Seibou oil well is operated by the Shell Petroleum Development Company (SPDC) in the Bayelsa State. The Bayelsa State is a state in southern Nigeria in the core Niger Delta region, between Delta State and Rivers State. Its capital is Yenagoa.

According to Amnesty-International (2015), the are currently two competing narratives about oil pollution in the Niger Delta. The first is that oil companies, particularly Shell, are responsible for massive pollution caused by leaks from their operations and for the failure to clean up spills and protect their infrastructure from damage. This narrative acknowledges that oil theft and sabotage of oil infrastructure occur and contribute to pollution, however it cautions that theft and sabotage, as causes of pollution, are over–stated by oil companies in a bid to deflect criticism about their environmental impact.

The second narrative claims that almost all spills are caused by oil theft and sabotage and that companies are doing their best to combat this scourge. It goes on to say that the failure to clean up properly is generally due to the communities not letting the oil companies into the area to do the cleanup.

It is not the purpose of this study to express any judgement on this highly controversial debate. In the light of the fact that Shell, the Nigerian government as well as members of affected communities were involved in the investigation into the causes of the Seibou spillage the report by the JIV[1] will be accepted for the purpose of this study.

The JIV published their report on 13 March 2015 in which it was confirmed that:

- An estimated 549 barrels of crude oil was discharged into Ogboinbiri River;
- The spill impacted 300 000 m^2 of water surface, an area roughly the size of 42 football fields in Bayelsa State;
- The spill was the result of equipment failure as a rupture had occurred on the six–inch crude flow line (Donavan (2015)) .

Evaluation of the Seibou oil spill: In Table 5.3 the Deepwater Seibou oil spill in the Niger Delta is evaluated against the criteria determined for the evaluation of successful PAMSE.

[1]After the Seibou spill became apparent a so–called Joint Investigation Visit (JIV) team was constituted. The JIV team, consisted of the Bayelsa State Commissioners of Environment, officials of SPDC, and agents of the National Oil Spills Detection and Response Agency (NOSDRA), a number of environmental Non Governmental Organizations (NGO)s, as well as members of affected communities.

Table 5.3: Evaluation of the Seibou oil spill

Execution criteria	**Evaluation**	**Pass/Fail**
Part 1: Strategic Alignment	Shell's commitment to the environment and to ethical exploration and production practices are widely published. Despite the fact that there were 50 times more oil spillage instances in the ND in 2014 than in Europe, the SPDC confirms that they are committed to the same ethical exploration and production practices published by Shell globally. The superficial evaluation done here does not point to any significant strategy misalignment between the major role-players or between the OSPs of the various major stakeholders and the executors in the Niger Delta.	Pass
Part 2: Applicability of Organizational Design and management systems	From the limited published information on the management and operations of the SPDC it is impossible to make any judgement on the applicability of the OD. The fact that oil spillage occur 50 times more frequently in the ND than in Europe however points to the fact that effective management systems are clearly not in place. Even in the event that the second narrative on the causes of the huge amount of oil spillage (referred to above) is accepted, the expectation would be that SPDC as an ethical and responsible organization would implement programmes and action plans in partnership with other stakeholder, to prevent the huge incidence of theft and sabotage. As indicated the investigation into the Seibou incident however clearly indicates that the spill was the result of equipment failure that could have been prevented if the PAMS were successfully executed.	Fail
Part 3: Readiness of interpersonal processes	Due to the relative recency of the incident at the time of writing this document very little detailed information regarding interpersonal processes at the Seibou well at the time of the incident were available. In the absence of a detailed assessment on the state of interpersonal processes within the organization, the management team will get the benefit of the doubt, and it will be accepted that the interpersonal processes were conducive to the successful execution of strategy.	Pass

Execution criteria	Evaluation	Pass/Fail
Part 4: Contribution of PAs to sustainable competitive advantage	Apart from the fact that the Seibou incident is a clear example of PAM SEF, the high incidence of oil spillage in the region and the potential negative impact this has on, not only the long term sustainability of the SPDC but the Niger Delta eco–system seem to be the biggest indication of the fact that the SPDC are failing with the execution of its PAMS.	Fail

The long term consequences: The Seibou oil spill has wide ranging implications and these include the following:

- The most obvious impact is the irrepearable damage the prolonged spillage of oil had on the sensitive ND eco–system;
- The exact extent of the long–term social and health impact these spills will have on the communities living in the area is difficult to determine. In the short and medium term residents of the coastal settlements in Ogboinbiri and neigbouring communities however indicated that the oil leak has damaged the fishing activities of the community. Many residents are also dependend on the river for drinking and domestic use and are thus compelled to resort to water sold in sachets. In the light of the fact that many people cannot afford the sachets the outbreak of cholera is a real threat;
- Hundreds of oil workers were deployed at the Seibou wellhead location start with the clean-up processs. Shell indicated that a major remediation operation would take place in the coming months, following an initial clean-up phase, but it did not disclose how long this would take, nor how much it would cost.
- Spillage problems in the ND have cost Shell about 65,000 barrels per day in production.
- It can be expected that Shell will have to pay compensation to the affected communities. It is still too early to estimate how much this would cost Shell, but during a out-of-court settlement that was reached after the well published 2008 Bodo spill, Shell agreed to pay $53.1 million to 15600 fishermen and farmers and $30.4 million to the Bodo community.
- The reputational damage these spills have on the Shell brand is in the final instance very difficult to determine. The image of Shell as a responsible and ethical corporate citizen is however seriously tarnished by the continued incidence of oil spills in the Niger Delta.

In the final example the electricity crises currently experienced in South Africa will be evaluated.

5.2.2.3 The electricity crises in South Africa

Background: South Africa (SA) has for many decades been the largest and most sophisticated economy in Africa[1]. The country's rich mineral wealth and associated industries as well as a climate that supports a large farming sector have allowed for significant development as a modern economy.

Eskom was established 90 years ago as a state owned power utility to provide energy at low cost. The utility supported the growth and development of all SA industries. Between 1960 and 1990 Eskom initiated a very rapid build programme that ramped electricity production to exceed 35GW. Eskom also developed the relevant transmission infrastructure to transport and distribute electricity. These capacities resulted in Eskom supplying 95% of all electricity in South Africa to date.

In 2013 the utility owned and operated about 43GW power generation assets consisting of 13 large Pulverized Fuel, coal-fired power plants equipped with 87 units, two nuclear Pressurized Water Reactors as well as hydraulic plants and Open Cycle Gas Turbines complementing the generation system.

Out of Eskoms full generating capacity of 43GW power, approximately 5,400MW are however lost everyday due to planned maintenance and an average of 6,845MW as a result of unplanned maintenance and breakages. With the average peak demand at 32,000MW the shortfall daily is about 3,000MW, or 4% of the overall grid capacity Preuss (2015). A planned:unplanned maintenance ratio of 44:56 is not sustainable and the high incidence of unplanned maintenance due to breakages illustrate the un-realibility of the plant within the Eskom context.

As in the case with the examples referred to above failure on the scale that is experienced within the Eskom context is rarely the result of only one incident or decision. Commentators and analysts have identified at least the following contributing factors:

- Economic growth and increasing demand of electricity;
- A decision by the South African government to stop the investment in new power generating capacity in the late 1990's;
- Skills shortage;
- Poor planning;

[1]Nigeria has recently overtaken South Africa from a perspective. Nigerian $509.9bn, compated to with South Africa's GDP of $370.3bn at the end of 2013. However, some economists point out that Nigeria's economic output is under-performing because at 170 million people, its population is three times larger than South Africa's. On a *per-capita* basis, South Africa's numbers are thus three times larger than Nigeria's (Dobbs *et al.* (2014)).

- The non-availability of the correct quality coal to feed the power stations; and
- PAM Strategy Execution Failure.

For the purpose of this discussion the focus will however fall on those aspects that are related to the PAM SEF.

The evaluation of the Eskom decision to defer maintenance Several commentators have alluded to the fact that the South African power crises is the result of poor PAM. Eskom management has also recently admitted that the severe strain on the power grid is due to deferred maintenance at its power stations. The inference of their admission is that deferred maintenance was a conscious decision and thus part of their PAMS. Eskom managers would in all likelyhood claim that the decision was taken in an attempt to align the Eskom PAMS with the strategic objectives determined by the SA government at the time. The SA government determined that "the lights should be kept on at all cost". Within the context of higher electricity demand and a decision by the SA government to stop investment in new power generation capacity Eskom executives would thus argue that they only way in which they could increase output from existing assets was to defer maintenance.

An argument could thus be made that despite the consequences of the decision to defer maintenance, the execution of the decision and thus the execution of the PAMS was successful.

In Table 5.4 their decision is evaluated against the criteria determined for the evaluation of successful PAMSE.

Table 5.4: Evaluation of the Eskom decision to defer maintenance

Execution criteria	**Evaluation**	**Pass/Fail**
Part 1: Strategic Alignment	In line with the requirement by the SA Government to ensure the availability of electricity despite generation capacity constrains, the conclusion can be made the PAMS was indeed aligned to the OSP.	Pass
Part 2: Applicability of Organizational Design and management systems	Although a detailed assessment of the applicability of the OD has not been done, superficial analysis do point to the fact that there are critical skills shortages within the organization. The is the result of a number of factors including restructuring has characterized the organization over the past two decades.	Fail

Execution criteria	Evaluation	Pass/Fail
Part 3: Readiness of interpersonal processes	In the absence of a detailed assessment on the state of interpersonal processes within the organization, the management team will get the benefit of the doubt, and it will be accepted that the interpersonal processes are condusive the successful execution of strategy.	Pass
Part 4: Contribution of PAs to sustainable competitive advantage	The current planned:unplanned maintenance ratio is by far the biggest indication of the fact that PAM SEF has occurred within the Eskom environment.	Fail

Based on the evaluation the counter argument, that will be made by many PAM practitioners and that is indeed the argument made in this study, is however that the decision by the Eskom management to defer maintenance on highly complex assets such as power generation plants should be regarded as a clear example of PAM SEF.

It is important to note that it is not the purpose of the evaluation to apportion blame, but to point out that in order to claim successful execution, the organization should consider all aspects of the PAMSE definition.

The long term consequences Apart from the inconvenience that the rolling power cuts cause for millions of the South Africans on a daily basis the South African economy is losing millions of rands every day as a result of the rolling power cuts. Due primarily to the impact on mining companies, economists have downgraded GDP growth forecasts significantly. The knock-on effect is that the crisis will ultimately limit the growth of South Africa to well below the 6% to which government has been aspiring. That level is required to produce enough jobs to halve the level of unemployment.

5.3 Conclusion

The complexities involved in the formulation of organizational strategy was illustrated in Chapter 2, and in Chapter 3, where it was illustrated that the execution of strategy is often even more complex than strategy formulation. In Chapter recent 4, Physical Asset Management Strategy (PAMS) developments were evaluated within the context of the organizational strategy and contemporary strategy discourse. In Chapter 5 the focus fell on the challenges involved in the execution of PAMS.

In line with the conclusion drawn in Chapter 4 that PAMS seem to be reactive and that PAM contributors do not dictate the strategy discourse agenda, it is not surprising to find very few publications dealing specifically with the challenges involved in PAM Strategy Execution. There is thus an enormous gap in the PAMBOK as most publications on PAM

tend to focus on aspects such as asset life cycle activities, advancing new methodologies for planning and assessment, and asset optimization.

Despite the fact that limited publications could be found on PAMSE specifically the concept was defined in Section 5.1. The definition was based on the definition of Contemporary Physical Asset Management (CPAM) defined in Section 4.3.1, the definition of Physical Asset Management Strategy defined in Section 4.4.1.3 and the definition of Strategy Execution defined in Section 3.1.

The focus then shifted to a discussion on the complexities and challenges involved in PAMSE. For the purpose of the discussion the framework developed by Yang *et al.* (2009), on factors contributing to SEF in general and introduced in Chapter 3, were used. The conclusion reached at the end of this evaluation was that despite the fact that very few peer reviewed publications dealing specifically with the challenges involved in PAMSE could be found it is important to note that there is strong coherence and correlation between the findings and recommendations made in other peer reviewed literature on PAM, and findings made on SE in general (discussed in detail in Chapter 3).

In Section 5.2.2 three prominent instances of PAM SEF were evaluated. The impact of PAM SEF was clearly illustrated in each on of these case studies.

In order to assist in the evaluation process a scorecard, based on the definition of PAMSE developed in Section 5.1, was developed. It was highlighted that the definition consists of four components or requirements namely:

- Part one refers to the importance of alignment between the PAMS and the OSP;
- Part two refers to the importance of Organizational Design and by implication also the availability of the right skills and competence as well as the availability and applicability of Strategy Control System and Management Control Systems.
- Part three refers to interpersonal readiness; and
- Part four refers to the fact that PAs should contribute to the creation of sustainable competitive advantage.

In Chapter 6 a model to assist practitioners with the early detection and prevention of PAM SEF will be developed. In the development of the model cognisance will be taken of the work done in all the preceding chapters, but specific reference will be made to the following three aspects. Firstly the framework on the nine recurring factors influencing SEF, (introduced in Section 3.2.1 and contextualized in Section 5.2.1). Secondly the definition of PAMSE (distilled and presented in Section 5.1), and thirdly the scorecard[1] (presented in Section 5.2.2) and used to retrospectively evaluate the prominent examples

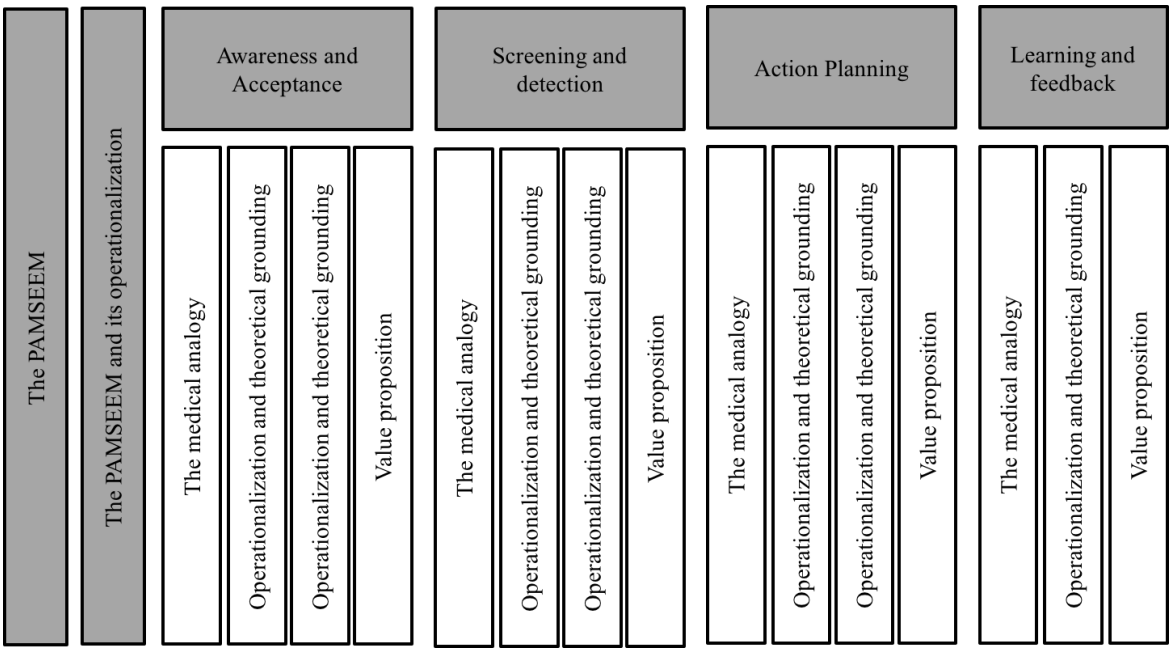
[1]As indicated in Section 5.2.2, the suggestion is not that this scorecard is the most comprehensive and effective tool to evaluate the successful execution of PAMS. It was merely used as an aid to assist in the evaluation of the mentioned examples.

of PAM Strategy Execution Failure. The scorecard will however be developed further in Chapter 6, and could be used in conjunction with the model for the early dection and prevention of PAM SEF.

Chapter 6

The early detection and prevention of PAMSEF

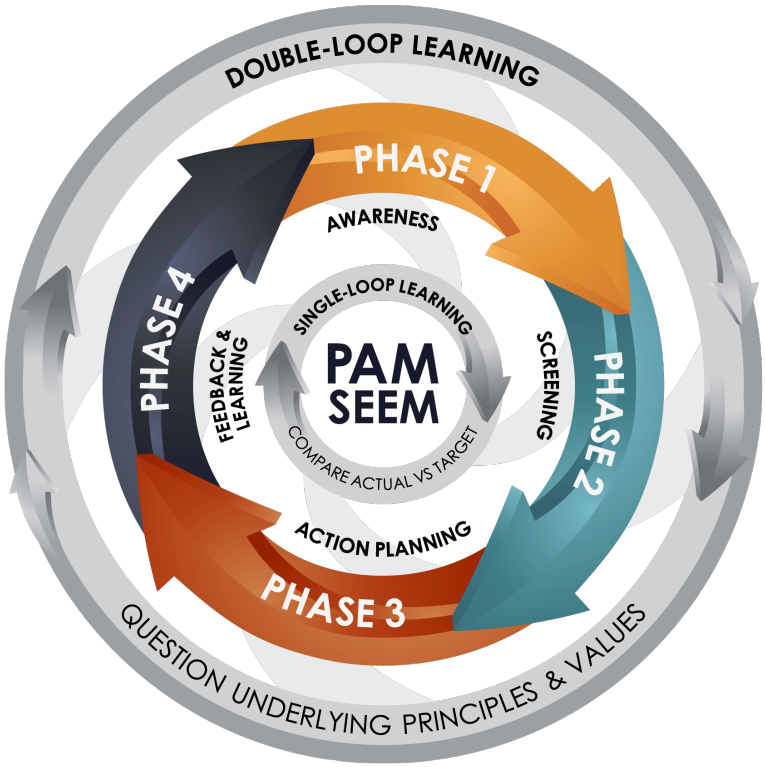
Figure 6.1: Chapter 6 Outline



In this chapter a model to assist practitioners with the early detection and prevention of PAMSEF will be presented. The mechanism will be referred to as the Physical Asset Management Strategy Execution Enforcement Mechanism (PAMSEEM)[1]. The PAM-

[1]It is important to note at this point that "Enforcement" within the context of this mechanism refers to the discipline of continuous detection, prevention and management of the underlying causes of PAMSEF.

Figure 6.2: The Physical Asset Management Strategy Execution Enforcement Mechanism



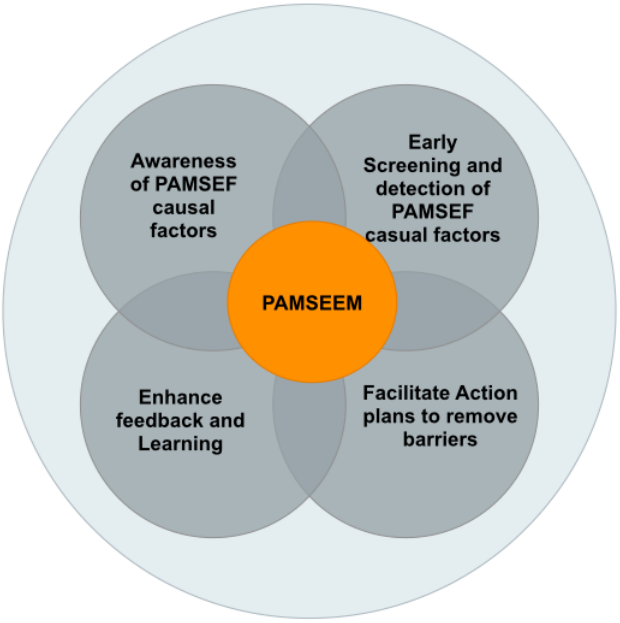
SEEM is illustrated in Figure 6.2. In line with the discussion on systems thinking in Section 2.4.1 the PAMSEEM is essentially a double–loop feedback system consisting of four iterative phases, four major decisions and a number of implementation processes or steps. The mechanism and its operationalization is discussed in detail in Section 6.1 and Section 6.2.

The purpose of the PAMSEEM is fourfold and illustrated in Figure 6.3. For ease of recognition and application by PAM practitioners, the acronym Awareness, Screening, Action Planning and Learning (ASAL) will be used in this text when reference is made to the purpose of the PAMSEEM.

At the outset of this chapter it is important to note that the characteristics of the screening and management of Cardio Vascular Diseases (CVD)s and Strategy Execution Failure (SEF) was found to be remarkably similar and the intuitiveness of the former provides a great platform to explain the latter. In the presentation of the model a number of references to the screening and management of CVDs will be thus made in an attempt to optimize the knowledge transfer process.

In the light of the fact that the PAMSEEM is not only a theoretical model to be used within the confines of a laboratory but a practical mechanism that should ultimately

Figure 6.3: The purpose of PAMSEEM



become part of the PAM organization's standard operations procedures and DNA the following principles used by marketing experts in the positioning of new brands and the launch of a new products were considered[1]:

1. Ease of recognition;
2. Simplicity and ease of use;
3. Cultural neutrality;
4. Quantitative analysis;

The objectives of this chapter is to:

- Introduce the PAMSEEM and discuss all its components;
- Present an operationalization framework;
- Ground the mechanism theoretically; and
- Present practical implementation guidelines.

In the next section the PAMSEEM is introduced. In the discussion specific reference to the analogy between CVD and SEF is made. The analogy is important because it will assist the knowledge transfer process and the implementation of the mechanism.

[1]These principles are discussed in more detail in Appendix B

6.1 The PAMSEEM

According to the World Health Organization (WHO), CVDs are the biggest cause of deaths worldwide. More than 17 million people die every year from CVDs. More than 3 million of these deaths occurred before the age of 60. The percentage of premature deaths from CVDs ranges from 4% in high-income countries to 42% in low-income countries (Mendis *et al.* (2011)).

CVDs thus undermine health, shorten life expectancy, and cause enormous suffering, disability, and economic costs. According to Mendis *et al.* (2011), CVDs are however largely preventable and both population wide measures and improved access to individual health care interventions can result in a major reduction in the health and socioeconomic burden caused by these diseases and their risk factors. Much of this disease burden could thus be avoided if there was systematic application of what is known about preventing the onset and progression of these conditions.

By addressing the underlying causes of CVD, and by improving the systems to detect and treat early-stage disease when interventions are most effective, significant reductions in disability and premature mortality could be achieved.

Screening for risk or early manifestations of CVD can reduce the incidence and mortality through recommendations for altered lifestyles, pharmacological interventions, or earlier treatment of the disease itself.

PAMSEF undermine organizational performance and often has serve implications for the long term sustainability of organizations and often impact stakeholders outside the organization as was clearly illustrated in the examples in Section 5.2.2.

Like CVDs, PAMSEF is also largely preventable if and when the risk factors and causes are early detected and managed. By addressing the underlying causes of PAMSEF, and by improving systems to detect and manage early indications of SEF when interventions are most effective, will significantly reduce the prevalence and impact of SEF.

During the extensive literature review (presented in the preceding chapters) it however became clear that currently no model or mechanism exist to assist PAM practitioners and academics in achieving this objective. The PAMSEEM was developed as an attempt to fill this void and represents the single biggest unique contribution to the field of this study. The mechanism is presented and explained in detail in the following sections. The objective of the mechanism is to assist academics and practitioners with the early detection and management of PAMSEF.

As indicated in the introduction to this chapter the PAMSEEM is essentially a double–loop feedback system consisting of four iterative phases, four major decisions and a number of implementation processes or steps. The phases, decisions and processes involved in the use of the mechanism are briefly introduced in Table 6.1.

Table 6.1: Abridged introduction to the PAMSEEM

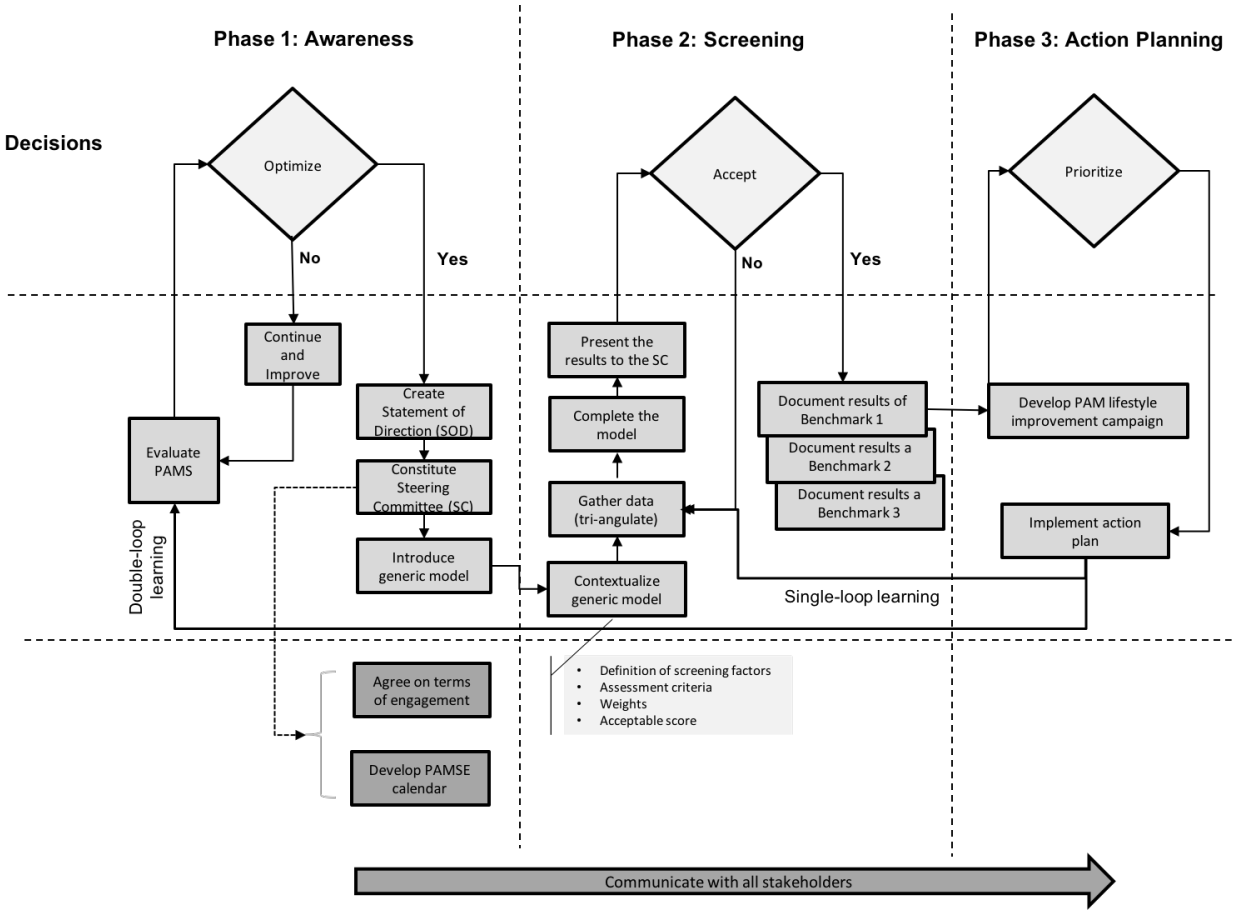
Phase	Major decisions	Processes
Phase 1: Awareness	The most important decision during the Awareness phase is the decision regarding the need to optimize.	• Step 1 – Constitute steering committee; • Step 2 – Evaluate PAMS; • Step 3 – Create Statement of Direction (SoD); • Step 4 – Introduce generic PAMSEEM; • Step 6 – Develop PAMSE calender; and • Step 7 – Continuous stakeholder communication.
Phase 2: Screening	The most important decision during the Screening phase is the acceptance of the results of the screening process.	• Step 1 – Contextualize the generic screening model; • Step 2 – Gather data; • Step 3 – Complete the model and calculate scores; • Step 4 – Interpret the results; and • Step 5 – Present the results.
Phase 3: Action Planning	The most important decision during the Action Planning phase relates to the prioritization of Action Plans. A number of methods to assist decision makers during the prioritization process is introduced.	• Step 1 – Develop Action Plans; and • Step 2 – Implement Action Plans.
Phase 4: Learning and Feedback	The most importance decision the PAM organization can take is to embrace the principles of continuous learning.	• Step 1 – Data acquisition; • Step 2 – Data analysis; and • Step 3 – Trade-off recommendations

In the next sections the phases, decisions and implementation steps involved in the operationalization of the PAMSEEM will be presented and contextualized in more detail.

6.2 PAMSEEM operationalization

The PAMSEEM is not only a theoretical model to be used within the confines of a laboratory but a practical mechanism that should ultimately become part of the PAM

Figure 6.4: The operationilization of the PAMSEEM



organization's standard operations procedures and DNA. In order to ensure the academic integrity of the mechanism and to facilitate the theoretical grounding of the mechanism regular reference will in the following sections be made to work done in the preceding chapters.

The practical value and contribution of the PAMSEEM will however be diminished if the mechanism is merely postulated as a theoretical framework. For this reason the practical operationalization of the model is also presented in huge detail in the next sections. In order to assist the PAM practitioner during the implementation of the PAMSEEM an operationalization framework is presented in Figure 6.4.

As indicated does the PAMSEEM essentially consist of four phases. The implementation of each one of these phases has value in its own right, and for this reason it was decided to promote these phases in the document hierarchy and to not only discuss them as subsections within the discussion on PAMSEEM operationalization. In the next sections the operationalization and value propositions of each one of the PAMSEEM phases

are thus discussed separately . In every discussion the following aspects will be addressed:

- The medical analogy;
- Theoretical grounding of the phase as well as major decisions taken during the phase;
- Introduction of various artefacts that could be used by practitioners and academics during the operationalization process;
- Operationalization of the phase; and
- Value proposition of the phase.

In order to assist readers a table summarizing the main points will be presented at the outset of every section. Each one of these aspects will then be discussed in more detail in the remainder of the section.

6.3 Awareness and acceptance

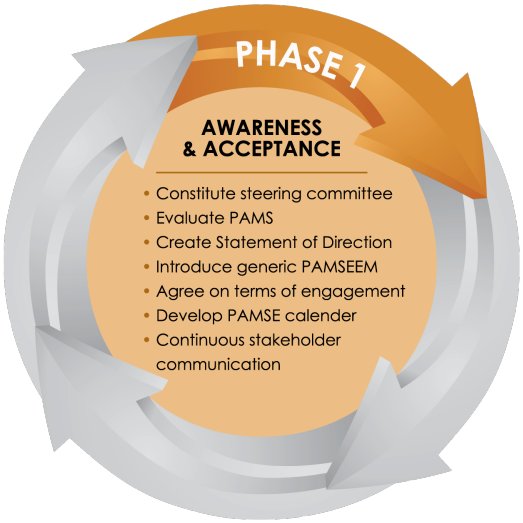
> *If, then, I were asked for the most important advice I could give, that which I considered to be the most useful to the men of our century, I should simply say: in the name of God, stop a moment, cease your work, look around you.*
>
> Leo Tolstoy, Essays, Letters and Miscellanies

The awareness and acceptance of the possibility that PAMSEF is a reality, is the first step in the development of a sustainable programme to ensure the early detection and prevention of failure. The "catalysts for change" can range from some form of awareness campaign, to sub-optimal Physical Asset performance or in the worst case some form of disaster. Awareness and acceptance within the context of the PAMSEEM is illustrated in Figure 6.5.

At this point it is important to again highlight the observations made by Miller (1997) and Dean & Sharfman (1996) regarding the correlations between organizational performance and Strategy Execution and referred to in Section 3.1.

In their quest to find an acceptable definition for Strategy Execution fundamental questions regarding the correlations between organizational performance and Strategy Execution were raised by these two authors and it was pointed out by them that corporate performance is not necessarily and indication of successful SE. The danger is thus that good corporate performance results often mask underlying problems and can potentially mislead decision makers, in the same way the absence of illness often masks the symptoms of CVD, and can lead to patient complacency.

Figure 6.5: Awareness and acceptance



In Table 6.2 an overview of the most important aspects involved during this phase is provided. These aspects include:

- The medical analogy;
- Major decisions and theoretical grounding;
- The Awareness phase process flow;
- Artefacts introduced or used during the phase; and
- The value proposition of the phase.

All these aspects are discussed in more detail in the remainder of Section 6.3.

Table 6.2: Awareness – The first step to prevention and management

Medical analogy

CVD	PAMSEF
• CVD accounts for the death of 505 000 women in the USA; • All cancers accounts for 269 900 deaths in women in the USA; • CVD is however far more preventable than cancer; • Surveys confirm that perceptions and awareness of the effect of CVDs are not in agreement with the severity and known consequences; • Lack of awareness impede effort to prevent and adopt positive lifestyles; • Patients often need a "Catalyst for Change" – such as the death of a relative, angina or stroke before change is initiated.	• Executives in organizations often deny the possibility of PAMSEF; • PAMSEF is largely preventable; • Lack of awareness impedes effort to prevent and adopt positive PAM lifestyles; • Organizations often need a "Catalyst for Change" – such as "a near miss", failure of a critical piece of equipment or total catastrophe before change is initiated.

Major decision and theoretical grounding

Decision:	**Description:**
Decision to optimize.	The most important decision during the Awareness phase is the decision regarding the need to optimize.
Reference:	**Theoretical grounding:**
Section 2.2	Sun Zsu already in 400BC described the importance of a superior strategy in the battle for scarce resources between competing tribes and nations, and the importance of awareness regarding current position and circumstances.
Section 4.4.3.3; Section 4.4.1.	PAMS until recently was not included in the main stream strategic discourse. The focus of middle to first line management has been on maintenance, and the optimization of maintenance processes. Limited organizational awareness (especially among first line and middle management) of the importance and impact of PAMSEF.

Section 4.1; Section 4.3.5; IAM (2011)	The IAM dedicate a whole section on PAM Risk and Review, but no universal definition of PAMS success, thus no universal yardstick.
Section 3.1 and Section 5.2.2.	In an attempt to fill the apparent void regarding a clear definition for PAMS success Strategy Execution criteria are introduced and contextualized. This criteria is used to create awareness of potential SEF.
Process flow	
Core Processes:	**Description:**
Step 1: Constitute steering committee	In an attempt to ensure stakeholder acceptance of the process, all possible stakeholders should be identified, consulted and represented in the PAMSEEM steering committee.
Step 2: Evaluate PAMS	Evaluate PAMS strategy using the criteria defined in Section 3.1 and Section 5.2.2.
Step 3: Create Statement of Direction	The formulation of the SoD is an highly iterative proses and involves the facilitation of a number of workshop during which the purpose of the mechanism is explained
Step 4 Introduce generic PAMSEEM	The generic PAMSEEM should be introduced to all stakeholders and explained in detail to the steering committee make a reference to Figure 6.2
Support Processes:	
Step 5: Agree on terms of engagement	The steering committee should agree on terms of engagement. Factors to consider includes but are not limited to: the mandate of the steering committee, meeting intervals and feedback mechanisms.
Step 6: Develop PAMSE calender	The calendar should highlight important milestones and include factors considered as part of the agreement on the terms of engagement.
Step 7: Continuous stakeholder communication	The steering committee should develop a communication and feedback strategy to ensure continuous stakeholder involvement and awareness.
Artefacts	
Reference:	**Artefact:**
Table 6.3	Example of PAM steering committee

Table 6.4	Scorecard for the high-level evaluation of PAMS success.
Table 6.5	Example of a PAMSEEM calendar
Figure 6.6	Typical PAMSEEM communications strategy format

Value proposition

In addition to the fact that the completion of both these processes are essential steps in the definition of the PAMSEEM Scope of Work (SoW), these processes plays in major role in raising awareness levels.

In the remainder of this section each one of the above aspects will be discussed in more detail. The importance of the theoretical grounding of the mechanism has been stated. Regular reference to work done in preceding chapters will thus be made in the following sections. In order to facilitate the flow of discussion these references will however be integrated in the text and will not be dealt with separately as was the case in the table above.

6.3.1 The Medical analogy

The concept awareness has been used for hundreds of years by many contributors within a range of performance environments. In Section 2.2, reference was made to the fact that Sun Zsu already in 400BC described the importance of a superior strategy in the battle for scarce resources between competing tribes and nations. In his writings that were later published in the widely referenced book "The Art of War", Sun Zsu also explains the importance of awareness of strategic position.

Within the context of health care numerous studies have pointed to the importance of awareness of health status as a first step to the prevention of illness (see Mosca *et al.* (2000); Mosca *et al.* (2004); Yun *et al.* (2011) and Pauwels *et al.* (2014)). In order to illustrate the importance of awareness within the healthcare context specific reference will be made to the study done by Mosca *et al.* (2000). In their study they have found that CVD in the year 2000, accounted for about $274 billion in direct health costs and indirect costs, including lost productivity, and for more than 505,000 deaths among women in the United States alone. In contrast, the average annual number of deaths from all cancers for women in the United States was 265,900, including 43,300 deaths from breast cancer. Surveys of women in the United States have however found that their perception of the effect of CVD is not in agreement with the severity of the known consequences of CVD

on morbidity and mortality. The authors concluded that the lack of awareness of the risk of CVD impede preventive efforts as well as the adoption of positive lifestyle changes.

The irony is however that CVDs often has no or very little symptoms in itself and patients often deny the possibility that disease might be a reality and delay preventative screening interventions. For this reason CVD is often referred to as the "silent killer". In recent years progressive and high-income governments has spend millions of dollars on CVD awareness and treatment campaigns. The impact of these campaigns is clear from the statistics quoted in the introduction to this chapter. According to the WHO:

> *"...premature deaths from CVDs ranges from 4% in high-income countries to 42% in low-middle income countries..."* (Mendis *et al.* (2011))

Executives within organizations, like patients, also often deny the possibility that PAMSEF is possible and even in those environments where progressive managers contemplate the possibility of PAMSEF very few mechanisms existed up to now that could assist them in the early identification of the presence of those factors that ultimately lead to PAMSEF[1].

For patients and organizations alike some form of "Catalyst for Change" is normally required to spark them into action. In the case of a CVD patient it might be the death of a close relative, angina, stroke or heart attack. In the case of the PAM organization the catalysts for change can range between "a near miss", the failure of a critical piece of equipment or in the case of the Deep Water Horizen oil disaster a total catastrophe.

6.3.2 Artefacts

The following artefacts are introduced in the following section:

- Table 6.3 – Example of PAM steering committee
- Table 6.4 – Scorecard for the high-level evaluation of PAMS success.
- Table 6.5 – Example of a PAMSEEM calendar
- Figure 6.6 – Typical PAMSEEM communications strategy format

These artefacts are discussed in detail in the section and will thus not be evaluated in separately in this section.

[1]It is important to make a clear distinction between equipment failure and Strategy Execution Failure. A large number of preventative maintenance practices and procedures have been developed over the years and are utilized effectively in most organizations. The focus here falls on Strategy Execution Failure.

6.3.3 Decisions and process flow

During the operationalization of Phase 1 of the PAMSEEM and in line with Figure 6.4, a number of decisions should be made, and implementation steps completed. These decisions as well as the implementation steps are discussed in more detail in this section. In order to ensure the academic integrity of the mechanism regular reference will be made to work done in the preceding chapters.

Major Decisions: The most important decision during this phase is to initiate the optimization process. As indicated above some "Catalyst for Change" is however normally required before action is taken. If the impetus for change is not significant enough or the risk for PAMSEF is very low, the organization needs to continue on its current path and apply TQM principles. If the risk for PAMSEF is however large enough or if the organization would like to confirm its assumed state of good health, it should follow the steps explained below.

Core Processes: Phase 1 requires the completion of four core processes or steps namely:

- **Step 1 – Constitute steering committee:** Once decision makers accept the reality that PAMSEF is possible even against the backdrop of good corporate performance, a PAMSEEM steering committee should be constituted. In an attempt to ensure stakeholder acceptance of the process, all possible stakeholders (especially executive management) should be identified, consulted and represented in the PAMSEEM steering committee. An example of the composition of a typical steering committee is reflected in Table 6.3.

Table 6.3: Example of the composition of a PAMSEEM steering committee

Stakeholder	**Role and responsibility**	**Skill Requirements**	Involvement
General Manager	Project Sponser: Finally repsonsible to sign-of the steering committee mandate and SoD. Need to secure and channel relevant resources to the steering committee. Need to represent the committee during interaction with stakeholders higher up in the organizational hierarchy (when applicable), or external organizational stakeholders.	– Leadership – Strategic Planning – Networking	Ad Hoc

Stakeholder	**Role and responsibility**	**Skill Requirements**	Involvement
Engineering Manager	Project Owner: Responsible for the constitution of the steering committee and facilitate the operational functioning of the steering committee. Coordinate and negotiate requirements between the sponsor and the organization. Provide overall leadership	– Business leadership; – Organizational skills; – People development skills; – In-depth understanding of PAM principles and practices; – Project management skills	Dedicated
Operations Managers	Key client and subject matter expert: The operations manager represent to operations. Translate and communicate existing challenges, bottlenecks and frustrations.	– Business leadership; – Technical expertize; – In-depth understanding of the business operations; and – Basic understanding of PAM principles and practices;	Dedicated
Asset Management Engineer (AME)	Represent every operational area, and contextualize the specific PAMSE challenges, bottleneck and frustrations.	– Business leadership; – Technical expertize; – In-depth understanding of the business operations; and – Basic understanding of PAM principles and practices;	Dedicated
Maintenance Foreman	Represent every operational area, and contextualize the specific PAMSE challenges, bottleneck and frustrations.	– Technical expertize; – Basic understanding of the business operations; and – Basic understanding of PAM principles and practices.	Ad hoc

Stakeholder	Role and responsibility	Skill Requirements	Involvement
Planner	Represent the functional process but also typically play the role of process administrator and co-ordinator in conjunction with the Project Owner.	– Planning; – Coordinating; – Analystical skills; – Basic understanding of the business operations; and – In-depth understanding of PAM principles and practices.	Dedicated
HR Manager	Facilitate steering committee team building and cohesion. Ensure compliance with company policies and procedures, and facilitate the data gathering process. (see discussion in Section 6.4.	– Team Building skills; – Coordinating; – Data gathering skills; – Detailed understanding of the business operations, policies and procedures; and – Basic understanding of PAM principles and practices.	Dedicated

- **Step 2 – Evaluate PAMS:** The first responsibility of the steering committee would be to evaluate the PAMS using the criteria defined in Section 3.1 and Section 5.2.2. A typical example of such an evaluation was illustrated in Table 5.3 in and is reproduced in Table 6.4 for ease of reference. The outcome of this evaluation should be well documented for future reference.

Table 6.4: Evaluation of the Seibou oil spill

Execution criteria	Evaluation	Pass/Fail
Part 1: Strategic Alignment	Shell's commitment to the environment and to ethical exploration and production practices are widely published. Despite the fact that there were 50 times more oil spillage instances in the ND in 2014 than in Europe, the SPDC confirms that they are committed to the same ethical exploration and production practices published by Shell globally. The superficial evaluation done here does not point to any significant strategy misalignment between the major role-players or between the OSPs of the various major stakeholders and the executors in the Niger Delta.	Pass

Execution criteria	Evaluation	Pass/Fail
Part 2: Applicability of Organizational Design and management systems	From the limited published information on the management and operations of the SPDC it is impossible to make any judgement on the applicability of the OD. The fact that oil spillage occur 50 times more frequently in the ND than in Europe however points to the fact that effective management systems are clearly not in place. Even in the event that the second narrative on the causes of the huge amount of oil spillage (referred to above) is accepted, the expectation would be that SPDC as an ethical and responsible organization would implement programmes and action plans in partnership with other stakeholder, to prevent the huge incidence of theft and sabotage. As indicated the investigation into the Seibou incident however clearly indicates that the spill was the result of equipment failure that could have been prevented if the PAMS were successfully executed.	Fail
Part 3: Readiness of interpersonal processes	Due to the relative recency of the incident at the time of writing this document very little detailed information regarding interpersonal processes at the Seibou well at the time of the incident were available. In the absence of a detailed assessment on the state of interpersonal processes within the organization, the management team will get the benefit of the doubt, and it will be accepted that the interpersonal processes were conducive to the successful execution of strategy.	Pass
Part 4: Contribution of PAs to sustainable competitive advantage	Apart from the fact that the Seibou incident is a clear extremely of PAM SEF, the high incidence of oil spillage in the region and the potential negative impact this has on, not only the long term sustainability of the SPDC but the Niger Delta eco–system seem to be the biggest indication of the fact that the SPDC are failing with the execution of its PAMS.	Fail

- **Step 3 – Create Statement of Direction (SoD):** Based on the findings of the PAMS evaluation the steering committee should formulate a SoD. The formulation of the SoD is an highly iterative proses and involves the facilitation of a number of workshop during which the purpose of the intervention is explained and justified. The SoD is the purpose statement of the PAMSEEM. A typical example of a SoD is illustrated below:

> *"The XYZ Company realizes the value that can be unlocked through the successful execution of it's PAM strategy. We accept the reality that a number of factors might prevent us from achieving our goals. We are committed to identify these factors pro-actively and to develop action plans to eradicate these factors or to minimize the possible effect they might have during the PAMSE process."*

- **Step 4 – Introduce generic PAMSEEM:** During a number of interactive workshops and meetings the generic PAMSEEM should be introduced to all stakeholders and explained in detail to the steering committee. The screening process as well as screening factors are discussed in detail in Section 6.4.

Support Processes: In addition to these core processes the steering committee should once formed also complete the following processes or steps:

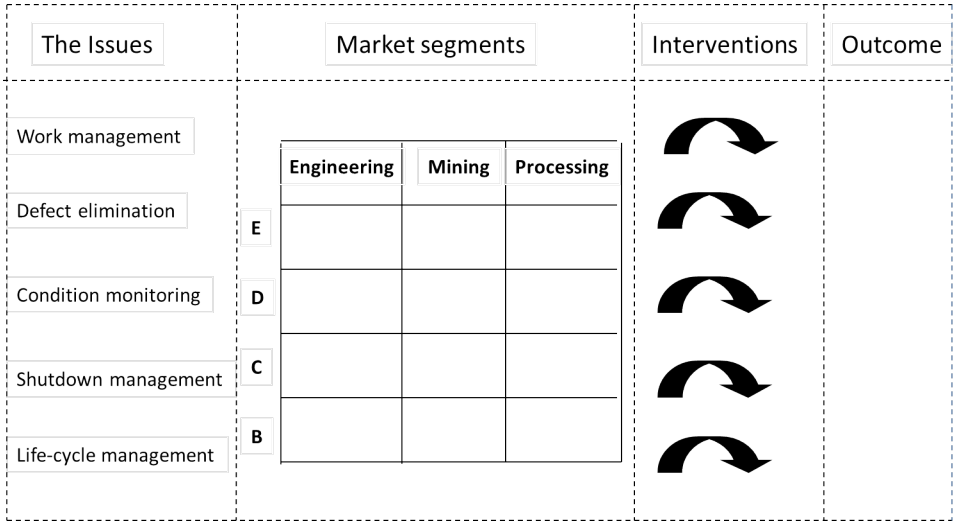
- **Step 5 – Agree on terms of engagement:** The steering committee should agree on terms of engagement. Factors to consider includes but are not limited to:
  - The mandate of the steering committee – During the screening process the steering committee would require access a wide range of information. In the absence of a clear mandate the screening process will become extremely cumbersome and slow if permission to obtain access to these information sources have to be obtained every time. A clear mandate would prevent this obstacle.
  - Meeting intervals – The implementation of the PAMSEEM does not require the full time effort of steering committee members. The steering committee would however request members to perform certain tasks and members need to report back on their findings. Meeting intervals should thus be determined by the steering committees level of activity. At the outset of the PAMSEEM implementation the steering committee would meet on a regular basis (during the initial screening stages a daily "check-in" session is recommended). Once the PAMSEEM have become part of the organizational lifestyle monthly steering committee meetings should suffice.
- **Step 6 – Develop PAMSEEM calendar:** Communication has in Section The calendar should highlight important milestones and include factors considered as part of the agreement on the terms of engagement. A typical example of a PAMSEEM calendar is illustrated in Table 6.5.

Table 6.5: PAMSEEM calendar

Phase	Processes	Completion Date
Phase 1: Awareness	– Step 1 – Constitute steering committee; – Step 2 – Evaluate PAMS; – Step 3 – Create Statement of Direction (SoD); – Step 4 – Introduce generic PAMSEEM; – Step 6 – Develop PAMSE calender; and – Step 7 – Continuous stakeholder communication.	28 August 2015
Phase 2: Screening	– Step 1 – Contextualize the generic screening model; – Step 2 – Gather data; – Step 3 – Complete the model and calculate scores; – Step 4 – Interpret the results; and – Step 5 – Present the results.	15 September 2015
Phase 3: Action Planning	– Step 1 – Develop Action Plans; and – Step 2 – Implement Action Plans.	To be confirmed
Phase 4: Learning and Feedback	– Step 1 – Data acquisition; – Step 2 – Data analysis; and – Step 3 – Trade-off recommendations	Ongoing

- **Step 7 – Continuous stakeholder communication:** Ineffective communication has in Sections 3.2.1 and 5.2.1 been identified as one of the most critical factors preventing organizations to successfully execute their strategies. In addition to steering committee meetings a communication and feedback strategy should be developed to ensure continuous stakeholder involvement and awareness. The typical structure of such a strategy is illustrated in Figure 6.6. The organizational circumstances and number of stakeholder groups would determine the exact nature and extent of feedback. Regular and appropriately formulated feedback that take cognisance of the characteristics of the audience is however essential. Stakeholder communication is thus a continuous process and is a critical element of the PAMSEEM.

Figure 6.6: Typical PAMSEEM communications strategy format



6.3.4 Value proposition

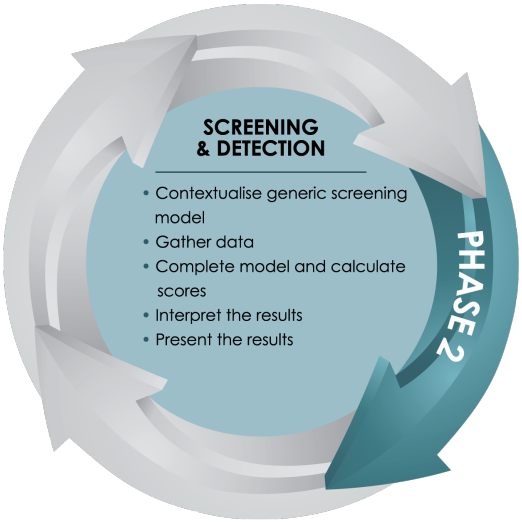
During Phase 1 PAM stakeholders are introduced to both the potential negative impact of PAMSEF and the factors that typically contribute and lead to SEF. In addition to the fact that an understanding of both these realities are essential steps in the definition of the PAMSEEM Scope of Work (SoW), an understanding of these processes plays in major role in raising awareness levels. Awareness in itself as illustrated by the research done by Mosca *et al.* (2000), and referred to in Section 6.3.1 plays a critical role in prevention.

6.4 Screening and detection

> *"The object of screening for disease is to discover those among the apparently well who are in fact suffering from disease. They can then be placed under treatment and, if the disease is communicable, steps can be taken to prevent them from being a danger to their neighbours. In theory, therefore, screening is an admirable method of combating disease, since it should detect it in its early stages and enable it to be treated adequately before it obtains a firm hold on the community"*
>
> Reproduced from Wilson & Jungner (1966).

The above quote was extracted from a document with the title *"Princiles and practice for the screening of disease"* published by the WHO in 1966. Over the years the

Figure 6.7: Screening and detection



WHO has published a number of screening protocols recommended to be used by health practitioners.

The importance of screening and early defect detection is however also recognized in a number of other fields (See for example Peng *et al.* (2012); Ngan *et al.* (2011) and Patel *et al.* (2012)). A detailed evaluation of these contributions however falls outside the scope of this section. Suffice to note that the importance of screening and early detection of the presence of factors causing illness or defects cannot be over emphasized.

During Phase 2 of the implementation of the PAMSEEM the focus falls on screening the organization for the detection of PAMSEF causal factors. The process requires the collection of both qualitative and quantitative data from a wide range of sources. Screening and dection within the context of the PAMSEEM is illustrated in Figure 6.9.

In Table 6.6 an overview of the most important aspects involved during this phase is provided. All these aspects are discussed in more detail in the remainder of Section 6.3.

Table 6.6: Screening – The evaluation of the current state

Medical analogy	
CVD	**PAMSEF**
Screening for CVD has three pre-requisites: • Thorough understanding of the factors that cause illness. In the case of CVD medical practitioners refer to the "deadly sextet" when discussion causal factors. • A methodology that can be used to screen these factors; and • A generally accepted way of reporting on the prevalence of theses factors to ensure that all stakeholders understand and interpret the report in the same way.	Screening for PAMSEF has three pre-requisites: • Thorough understanding of the factors that cause PAMSEF. In this study 10 factors were identified and are referred to as the Deadly Dectet Factor (DDF) of PAMSE; • An instrument that could be used to screen for these factors; and • A reporting mechanism that PAM practitioners could use to interpret and screening results.

Major decisions and theoretical grounding	
Decision:	**Description:**
Accept the results of the screening report.	The most important decision during the Screening phase is the acceptance of the screening report. In the same way that an overweight patient that is in denial will not be able to change his/her life style, a PAM organization that does not accept the results of the screening report will not be able to develop and implement improvement and organizational life style change plans.
Reference:	**Theoretical grounding:**
Section 2.2.3; Section 4.3.5.1	Typical requirements of well formulated strategy in general and PAM strategy specifically
Table 3.1; Table 3.2; Table 3.3; Section 3.2.1; Section 5.2.1 and Section 4.3.5.1.	The impact the "executors of strategy" has on SE and PAMSE specifically.
Section 2.3.3; Section 3.2.1; Section 4.4.2.3, Section 4.3.5.5 and Section 5.2.1.	The importance of contemporary Organizational Design in PAMSE.
Section 3.2.1 and 5.2.1.	The role and importance of Interdepartmental Relations in SE in general and PAMSE specifically.
Section 2.4, Section 2.4.5, Section 2.4.6, Section 4.4.3, Section 3.2.1 and Section 5.2.1.	The role and importance of Management Control System in PAMSE

Section 4.3.4, Section 4.3.5 and Section 4.3.5.6.	The evolution and of PAM systems, processes and practices and the role of standardization during PAMSE.
Table 3.1, Table 3.2, and Table 3.3 and discussed in detail Section 3.2.1, 3.2.2, 3.2.2.2 as well as Section 5.2.1 and Section 4.3.5.1	The impact communication has on SE and PAMSE specifically.
Section 3.2.1 and Section 5.2.1	The importance and use of appropriate Change Management Tactics.
Table 3.1, Table 3.2, Table 3.3, Table 3.4 and Section 3.2.1, 3.2.2, 3.2.2.2 as well as Section 4.3.5.1 and Section 5.2.1.	The role and importance of consensus on strategic goals and agreement on strategic priorities.
Table 3.1, Table 3.3, Table 3.5 and Table 3.6 and discussed in detail Section 3.2.1, 3.2.2, 3.2.2.2 as well as Section 4.3.5.1 and Section 5.2.1	The role and importance of staff commitment during SE in general and PAMSE specifically.
Section 3.2.1.	Eisenstat & Beer (2000) uses the analogy of cholesterol when describing what they refer to as the six silent killers of Strategy Implementation and learning.
Section 3.2.1; Section 5.2.1.	The nine most recurring factors contributing to SE failure were identified and contextualized.
Section 5.2.1.	The possibility of iteration, modification and the addition of derivatives were clearly stated
Section 4.3.5.6.	Introduction and contextualization of the MAMAT as well as the Likert Scale when evaluating PAM components.

Process flow

Core Processes:	**Description**
Step 1: Contextualize generic screening model	Depending on the specific circumstances the PAMSEEM should be contextualized. This includes the adjustment of factor weights and agreement on evaluation methodology.
Step 2: Gather data	Qualitative as well quantitative performance data should be gathered to evaluate the various DDFs.
Step 3: Complete model and calculate scores	All gathered data should be imported into the model and calculations should be made in order to determine the DDF scores.

Step 4: Interpret the results	The various scores should be interpreted in line with general interpretation guidelines (see Table 6.8 as well as the decisions that were taken during the contextualization of the PAMSEEM (see Step 1 of the Screening operationalization process).
Step 5: Present the results	The results should finally be presented to all stakeholders during appropriate sessions.
Artefacts	
Reference:	**Artefact**
Table 5.1	Scorecard for the highlevel evaluation of PAMS success.
Figure 6.8	The Deadly Dectet Factor of PAMSEF
Figure 6.9	The PAMSEF generic scorecard
Table 6.7	A completed PAMSEF Results Report
Section 6.4.2.2	Screening calculations
Table 6.8	PAMSEF Report: Interpretation Guideline
Table 6.9	Example of a completed PAMSEF DDF Report
Value proposition	
The outcome of the screening process is a report that is comparable to a pathology or radiology report. As in the case with the planning of a patient treatment plan, the PAMSEEM screening report will empower decision makers to make informed decisions when developing action plans to address risk areas pro-actively.	

In the remainder of this section each one of the above aspects will be discussed in more detail. The importance of the theoretical grounding of the mechanism has been stated. Regular reference to work done in preceding chapters will thus be made in the following sections. In order to facilitate the flow of discussion these references will however be integrated in the text and will not be dealt with separately as was the case in the table above.

6.4.1 The Medical analogy

Within the medical context effective screening and early detection have at least three pre-requisites:

1. A thorough understanding of the factors that cause the illness – Medical practitioners for example refer to the "deadly sextet" when discussing CVD causal factors. These factors include:
   (a) Abnormal glucose tolerance;
   (b) General obesity;
   (c) Upper-body obesity;
   (d) Hypertension;
   (e) Low HDL-cholesterol; and
   (f) Hypertriglyceridemia.
2. A methodology that can be used to screen these factors – There are numerous ways to screen for CVD casual factors and new instruments and test methods are regularly published; and
3. A generally accepted way of reporting on the prevalence of these factors, to ensure that all stakeholders understand and interpret the report in the same way – Over many years reporting on these factors have also become standardized and medical practitioners the world over for example know what a Blood Pressure reading of 145/90 mean and that a Total Cholesterol reading of 6.2 is meaningless if the readings for LDL and HDL is not also available.

Like screening for CVD the screening and early detection of PAMSEF also have three pre-requisites:

- A thorough understanding of the factors causing or contributing to PAMSEF.
- An instrument that can be used to screen for these factors; and
- A reporting mechanism, that could become a standard and that would enable PAM practitioners and academics the world over to interpret screening results.

As indicated in the introduction to this chapter it became clear after an extensive literature review that currently no model or methodology exists to empower and enable PAM practitioners and academics to screen and detect factors causing PAMSEF. A number of Screening Artificats thus had to be developed to enable and assist PAM practitioners and academics during the screening process. It is important to understand these artefacts and instruments before discussing the operationalization of the Screening phase. These artefacts are introduced and discussed in more detail in Section 6.4.2. The operationalization of these instruments are discussed in Section 6.4.3.

6.4.2 Screening artefacts

A number of artefacts are used during the Screening phase and presented in the following paragraphs.

6.4.2.1 The Deadly Dectet (DD) of PAMSEF

Despite the fact that it is not the purpose of the study to introduce yet another framework categorizing the factors impacting on successful PAMSE (see Section 3.2.1 and Section 5.2.1), it was indicated in Section 5.2.1 that the application of the PAMSEEM might require iteration, modification and the addition of derivates or combinations of specific factors, depending on the specific context.

In Section 5.2.1 a basic scorecard was introduced to assist in the evaluation of a number of examples of PAMSEF. This scorecard consists of four components and is based on the four components or requirements of the definition of PAMSE formulated in Section 5.1. These four components are:

- The quality and applicability of the Physical Asset Management Strategy;
- The quality and applicability of the PAM Organizational Design and management systems;
- The quality of interpersonal processes (such as communication, consensus and change management); and
- The extent to which the PAs contribute to the creation of sustainable competitive advantage.

In order to simplify and structure the screening process it was decided to use the first three components of the PAMSE definition as a framework to categorize the nine casual factors. The fourth component "contribution to the creation of sustainable competitive advantage" is a lagging indicator or a symptom within the context of the medical analogy. In the light of the evaluation of recent examples of PAMSEF (see the discussion in Section 5.2.2) it was furthermore decided to include a tenth factor referring to "the non-adherence of generally accepted PAM practices and procedures". In line with the CVD analogy used in this chapter these ten factors are referred to as the "Deadly Dectet (DD) of PAMSEF". These factors are illustrated in Figure 6.8.

The categorization is thus not an attempt to illustrate possible causal relationships that might exist between various DDFs. It is purely used to assist users during the administration of the mechanism and to enable improved communication and feedback regarding the PAMSEEM.

Figure 6.8: The Deadly Dectet (DD) of PAMSEF

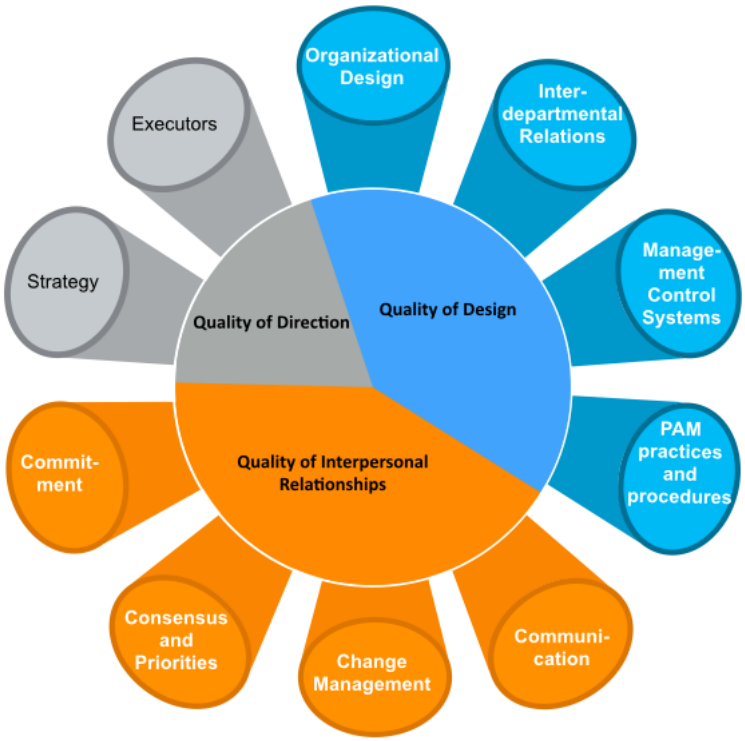
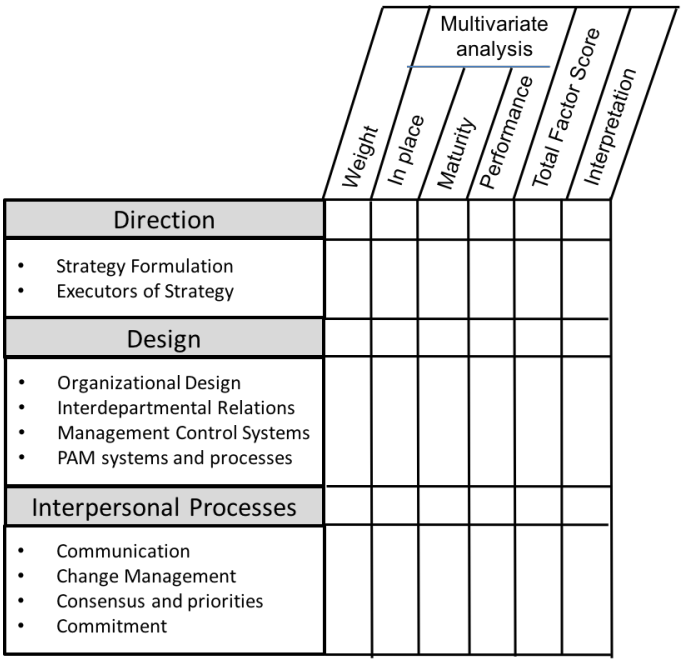


Figure 6.9: The PAMSEEM generic scorecard



6.4.2.2 An instrument for screening PAMSEF causal factors

For the purpose of screening a scorecard was developed that can be used to evaluate all causal factors in an integrated way.

An abridged version of the scorecard is illustrated in Figure 6.9 and consist of the following components:

- The list of causal factors (the Deadly Dectet Factor (DDF)s) categorized in line with the definition of PAMSE;
- A number of specific contextual conditions and realities might have an impact on the relative importance of each one of these causal factors. For this reason the ability to weigh causal factors to indicate relative importance is considered to be an important feature of the scorecard. This component is referred to as the Factor Weight (FW);
- In Section 4.3.5.6 the Multivariate Asset Management Assessment Topograhpy (MAMAT) that was recently developed by the Asset Care Research Group (ACRG) at Stellenbosch University was introduced as a PAS 55 assessment methodology. The methodology was found to be extremely useful and applicable during the development of the screening instrument for PAMSEF.

A Multivariate Assessment Topography (MAT) was thus also developed to be used as part of this screening instrument, and PAMSEF causal factors are evaluated in three dimensions:

1. In place – mainly referring to the availability and quality of strategies, policies, procedures and action plans;
2. Maturity – mainly referring to organizational awareness and understanding of available strategies, policies, procedures and action plans; and
3. Performance – mainly referring to the perceptions of key stakeholders regarding the extent to which goals and objectives are achieved.

Each one of these dimensions are measured using a five level Likert scale. The history and use of the Likert scale was discussed in more detail in Section 4.3.5.6. It was illustrated that a Likert scale is the sum of responses on several Likert Item (LI). A LI is simply a statement that the respondent is asked to evaluate by giving it a quantitative value on any kind of subjective or objective dimension, with level of agreement/disagreement being the dimension most commonly used. The format of a typical five-level LI, for example, could be:

1. Strongly disagree;
2. Disagree;
3. Neither agree nor disagree;
4. Agree; and
5. Strongly agree.

It is not the purpose of this study to develop an exhaustive list of LIs or questionnaires to evaluate each one of the DDFs of PAMSEF. In Section 6.4.3 examples of typical questions as well as factors practitioners should consider in the development of questionnaires will however be provided.

- The final component of the PAMSEF scorecard is the results column. The PAMSEF Score (PAMSEFS) is determined through relatively simple calculation. The formulae is illustrated below:

  1. Calculate the "In Place Score (IPS)" for every Deadly Dectet Factor (DDF) by using the following formula:

$$\text{IPS} = \frac{\sum \text{LI}_1^{\text{IPS}} + \text{LI}_2^{\text{IPS}} + ... + \text{LI}_n^{\text{IPS}}}{n} \tag{6.1}$$

  2. Calculate the "Maturity Score (MAS)" for every DDF by using the following formula:

$$\text{MAS} = \frac{\sum \text{LI}_1^{\text{MAS}} + \text{LI}_2^{\text{MAS}} + ... + \text{LI}_n^{\text{MAS}}}{n} \tag{6.2}$$

3. Calculate the "Performance Score (PS)" score for every DDF by using the following formula:

$$\text{PS} = \frac{\sum \text{LI}_1^{\text{PS}} + \text{LI}_2^{\text{PS}} + ... + \text{LI}_n^{\text{PS}}}{n} \tag{6.3}$$

4. Calculate the "Total Factor Score (TFS)" for every DDF by using the following formula:

$$\text{TFS} = \frac{\sum \text{Factor Weight (FW)} \times (\text{IPS} + \text{MAS} + \text{PS})}{3} \tag{6.4}$$

5. Calculate the total possible unweighted score for any DDF "Total Possible Contribution (TPC)" by using the following formula[1]:

$$\text{TPC} = \frac{\sum \text{MAT dimension}_1 + \text{MAT dimension}_2 + ... + \text{MAT dimension}_n}{n} \tag{6.5}$$

6. It is important to note that the TFS of a specific DDF might appear potentially meaningless if it is not considered in relation to the Total Relative Contribution (TRC) of the specific DDF. The TRC is calculated by using the following formula:

$$\text{TRC of a DDF} = \text{TPC} \times \text{Factor Weight (FW)} \tag{6.6}$$

7. When the TRC of a DDF is calculated the TFS can be expressed as a percentage, and this will assist stakeholders with the interpretation of the scores. The following calculation is used to express the TFS as a percentage of the TRC:

$$\text{TFS \%} = \frac{\text{TFS}}{\text{TRC}} \times 100 \tag{6.7}$$

8. Calculate the PAMSEF Score (PAMSEFS) by using the following formula:

$$\text{PAMSEFS} = \sum \text{TFS DDF}_1 + \text{TFS DDF}_2 + ... + \text{TFS DDF}_n \tag{6.8}$$

The results of these calculations are typically presented in a table format. An example of such a table is presented in Table: 6.7. The scores used in the table are not based on any reality and are purely used for illustrative purposes.

[1]The formula is based on the assumption that a five level Likert scale will be used, and that the Multivariate Assessment Topography (MAT) dimensions carry the same relative weight. The implication is thus that every one of the MAT dimensions will have a total potential contribution of five. If these assumptions are true the Total Possible Contribution for any DDF will always be five

Table 6.7: PAMSEFS screening results report

Deadly Dectet Factor	FW	TPC	IPS	MAS	PS	TFS	TFS %
Quality of Direction							
Strategy Formulation	20%	3.00	4	3	2	2.00	66%
Executors of Strategy	15%	2.25	4	4	2	1.50	66%
Quality of Design							
Organizational Design	5%	0.75	3	3	2	0.35	46%
Interdepartmental Relations	5%	0.75	2	1	1	0.20	26%
Management Control Systems	10%	1.50	5	5	5	1.50	100%
PAM Systems, Processes and Practices	10%	3.00	4	3	1	0.90	30%
Quality of Interpersonal Processes							
Communication	20%	3.00	4	3	2	1.80	60%
Change Management	5%	0.75	3	2	2	0.35	46%
Consensus and Priorities	5%	0.75	2	2	2	0.30	40%
Commitment	5%	0.75	2	2	2	0.30	40%
Totals	**100%**	**15**				**8.9**	**59%**

6.4.2.3 The PAMSEF DDF report

The third and final pre-requisite for the screening and detection of PAMSEF is the development of a generally accepted way of reporting on the prevalence of these DDFs, to ensure that all stakeholders understand and interpret the results or PAMSEF Score in the same way. It is important to note that cognisance should be taken of the Factor Weight of each DDF when scores are interpreted. This is especially important when decisions regarding the prioritization of Action Plans (see Section 6.5) are made. A general interpretation guideline is presented in Table 6.8:

Table 6.8: PAMSEF Report: Interpretation Guideline

Score range	Interpretation guideline
0% – 50%	Immediate action is required irrespective of the relative importance of the DDF.
51% – 60%	Immediate action is required if the DDF carries a weight of more than 15%. If the DDF carriers a weight of less than 15% the DDF should however still be closely monitored and is at all practical evaluated at least every three months.

Score range	Interpretation guideline
60% – 75%	No immediate action is required except if this is the lowest scoring DDF, and the organization has resources available. The DDF should however be closely monitored and evaluated at least every six to twelve months.
75% – 85%	No immediate action is required. Should be evaluated on an annual basis.
85% plus	No immediate action is required, and an indication of a very healthy state of affairs. Should be used as a benchmark and the conditions contributing to the score should be evaluated, to ensure repeatability.

During the contextualization of the screening model process (see Section 6.4.3, Step 1) the steering committee need to customize the PAMSEEM artefacts to suit the specific context. The above score ranges may at this point be adjusted. In order to ensure consistent and reliability interpretation of results the score ranges should however not be changed after the initial adjustment.

A typical example of a PAMSEF DDF report is presented in Table 6.9. In this particular report only the Total Factor Score % is interpreted.

Table 6.9: An example of a PAMSEF DDF Report

Deadly Dectet Factor	**FW**	**TFS%**	**Interpretation**
Quality of Direction Strategy Formulation	20%	66%	The quality of the PAMS is acceptable, regular review is however recommended to ensure continuous alignment with the organizational strategy.
Executors of Strategy	15%	66%	The executors of the strategy seem relatively competent. In line with the fact that this is a complex DDF referring to an number of factors including top management, middle management and staff competence and considering its relative importance it is however recommended that the factor should be evaluated in more detail in the next three to six months.
Quality of Design			

Deadly Dectet Factor	FW	TFS%	Interpretation
Organizational Design	5%	46%	Despite the relative low weight that Organizational Design carries within this context, the score is very low and immediate action is required. Long term sustainablity is not possible within the context of a non-functional Organizational structure. It is thus recommended that the underlying factors evaluated during the assessment of the OD should be evaluated in detail and that a detailed improvement plan (that may include Organizational re-design) should be formulated.
Interdepartmental Relations	5%	26%	Despite the relative low weight that Interdepartmental relations carries within this context the score is extremely low. This score should be read in conjunction with the low score for OD. It is recommended that a detailed analysis of all stakeholder relationship dynamics is made, and that based on the in-depth understanding of these dynamics a detailed Action Plan is developed.
Management Control Systems	10%	100%	The MCS seem to be working very well. It is recommended that practitioners should continue with the maintenance and management of the system. This factor need to be evaluated again in the next twelve months.
PAM Systems, Processes and Practices	10%	30%	PAM Processes and Systems seem to be defined and are "In Place". All stakeholders are however not aware of the practices and processes, do not understand or accept them. This in the final instance result in the poor overall performance of this DDF. It is thus strongly recommended that an Action Plan is developed to ensure greater awareness and understanding of PAM Systems and Practices. It is also recommended that this factor is monitored closely and evaluated on a three monthly basis until such time that the score increase.
Quality of Interpersonal Processes			
Communication	20%	60%	Organizational communication is central to most processes including training, knowledge management and learning. The communication score is borderline low and it is strongly recommended that the communication dynamics within the organization is evaluated in more detail. Based on the finding of the in-depth analysis an Action Plan should be developed to address communication inefficiencies.

Deadly Dectet Factor	FW	TFS%	Interpretation
Change Management	5%	46%	Evidence could be found of some change management tactics and practices currently being employed within the organization. Despite the fact that Change Management carries a relatively low weight the non-acceptance of these tactics as well as the non-performance of these tactics has a significant impact on the performance of a number of other DDFs. For this reason it is recommended that the organization investigates the effectiveness of Change Management tactics in far more detail. Specific cognisance should be taken of the cultural values of all stakeholders to ensure the use of appropriate Change Management tactics.
Consensus and Priorities	5%	40%	In line with the fact that Interdepartmental Relations are not optimal, relatively poor Communication and use of Change Management tactics, there is very little Consensus among stakeholders regarding strategic and operational priorities. The lack of strategic consensus has huge implications for successful SE, and strong evidence of silo thinking was identified. Consensus and agreement of priorities is typically a leading factor that should be addressed when factors such as Interdepartmental Relations, Organizational Design and Communication are addresses. It is however strongly recommended that this factor should monitored and evaluated on a three monthly basis.
Commitment	5%	40%	In line with all the other factors in the "Quality of Interpersonal Processes" group of factors Commitment to the Physical Asset Management Strategy seem to be lacking. Commitment to organizational and strategic goals is a lagging indicator and should be addresses when factors such as Interdepartmental Relations, Communication and Change Management are addressed. It is however strongly recommended that Commitment levels should be monitored and evaluated on a three monthly basis.
Total		**59%**	The PAMSEFS is border-line critical. Although the PAM organization might at this juncture still achieve seemingly good results, thereis a range of critical factors that need to be addressed to prevent PAMSEF in the short and medium term.

6.4.3 Decisions and process flow

During the operationalization of Phase 2 of the PAMSEEM and in line with Figure 6.4, a number of decisions should be made, and implementation steps completed. These decisions as well as the implementation steps are discussed in more detail in this section. In order to ensure the academic integrity of the mechanism regular reference will be made to work done in the preceding chapters.

Major Decisions: The most important decision during the Screening phase is the acceptance of the screening report. In the same way that an overweight patient that is in denial will not be able to change his/her life style, a PAM organization that does not accept the results of the screening report will not be able to develop and implement improvement and organizational life style change plans. During the presentation of the screening report questions may arise regarding the legitimacy and accuracy of the results. In the same way patients are shocked and sometimes even angry when a unexpected diagnosis is made, organizations are often shocked even angry when the results of a screening report is not favourable. The first reaction may often then be to "kill the messenger". The constitution of an effective, well represented and respected steering committee is therefore critical.

Core Processes: Phase 2 requires the completion of five core processes or steps namely:

- **Step 1 – Contextualize generic screening model:** Depending on the specific circumstances the PAMSEEM should be contextualized. This includes the adjustment of factor weights and agreement on evaluation methodology.
- **Step 2: Gather data:** Qualitative as well quantitative performance data should be gathered to evaluate the various DDFs. Examples of typical questions as well as factors practitioners should consider in the development of questionnaires is illustrated in Table 6.10.
- **Step 3: Complete the model and calculate scores:** All gathered data should be imported into the model and calculations should be made in order to determine the DDF scores.
- **Step 4: Interpret the results:** The various scores should be interpreted in line with general interpretation guidelines (see Table 6.8 as well as the decisions that were taken during the contextualization of the PAMSEEM (see Step 1 of the Screening operationalization process).
- **Step 5: Present the results:** The results should finally be presented to all stakeholders during appropriate sessions.

Table 6.10: Examples of DDF screening questions

Deadly Dectet Factor	**Typical Screening questions and factors to consider**
	Quality of Direction
Strategy Formulation	The questions and factors referred to below is based on the theoretical considerations discussed in Section 2.2.3 and Section 4.3.5.1. 1. Has the organization formulated or revised the Physical Asset Management Strategy in the past 12 months? 2. Is the PAMS well documented? 3. Is the PAMS aligned to the organizational strategy? 4. Is the PAMS consistent with the AM policy? 5. Is the PAMS risk-based in its approach, i.e. are activities prioritized according to the criticality of the asset? 6. Is the life cycle of assets specifically considered in the PAMS? 7. Were all stakeholders involved during the formulation the PAMS? 8. Does the PAMS include present and future functional, performance and condition requirements for the assets, and is a roadmap available to illustrate how these will be met?
Executors of Strategy	The questions and factors referred to below is based in theoretical considerations referred to in Table 3.1, Table 3.2, and Table 3.3 and discussed in detail Section 3.2.1 as well as Section 5.2.1 and Section 4.3.5.1. 1. Does executive management understand and support the importance of the PAMS? 2. Does departmental leaders understand the PAMS? 3. Does managers and down–the–line have adequate PAM skills and competence? 4. Does the existing management style match the strategic priorities (i.e. a "differentiation strategy" requires managers with a high locus of internal control, while a "build" strategy requires managers with a willingness to accept risk (see complete discussion in Section 3.2.1.
	Quality of Design

Deadly Dectet Factor	Typical Screening questions and factors to consider
Organizational Design	The questions and factors referred to below is based on the theoretical considerations discussed in Section 2.3.3, Section 3.2.1, Section 4.4.2.3, Section 4.3.5.5 as well as Section 5.2.1. 1. Has the PAM organization design been revised after the PAMS was updated? 2. Can the organization easily respond to changes in the external environment? 3. Are tasks centrally and narrowly defined? 4. Are staff members highly specialized or deployed as part of multi-functional teams; 5. Are reporting structures very rigid or does team members sometimes report to multiple managers at the same time? 6. Are teams responsible for the completion of whole tasks? 7. Are administrative functions such as planning, regulation and evaluation under the control of the team? 8. Does the organization understand agile design principles?
Interdepartmental Relations	The questions and factors referred to below is based on the theoretical considerations discussed in Section 3.2.1 and 5.2.1. 1. Are departments and teams working in silos? 2. Are there any cross departmental teams in the organizations? 3. Are group norms actively fostered? 4. Has any cross-departmental goals been formulated? 5. Does group norms as opposed to rules and regulations govern interdepartmental interaction?

Deadly Dectet Factor	Typical Screening questions and factors to consider
Management Control System (MCS)s	The questions and factors referred to below is based on the theoretical considerations discussed in Section 2.4, Section 2.4.5, Section 2.4.6, Section 4.4.3, Section 3.2.1 and Section 5.2.1. 1. Are there any MCS such as Balanced Scorecard, EVA, ABC or Six Sigma deployed within the total organization? 2. Did the organization revisit the MCS and decision making framework after the PAMS was updated? 3. Are there MCS such as Balanced Scorecard or EVA, ABC or Six Sigma deployed within the PAM organization? 4. Do decision makers have easy access to performance data? 5. Are PAM decisions mostly based on intuition or mostly based on facts? 6. Are Asset Management decisions in the organization mainly focused on individual assets or asset systems and the total asset portfolio?
PAM Systems, Processes and Practices	The questions and factors referred to below is based on the theoretical considerations discussed in Section 4.3.4, Section 4.3.5 and Section 4.3.5.6. 1. Is the organization familiar with the content of PAS 55 or ISO 55000? 2. Did the organization recently conduct a PAM systems audit? 3. Did the organization update the asset risk register in the past 12 months? 4. Are there action plans to address audit findings well documented? 5. Are action plans implemented by following a Plan-Do-Check-Act or similar cycle? 6. Does the organization have an up dated asset register?
Quality of Interpersonal Relations	

Deadly Dectet Factor	Typical Screening questions and factors to consider
Communication	The questions and factors referred to below is based on the theoretical considerations discussed in Table 3.1, Table 3.2, and Table 3.3 and discussed in detail Section 3.2.1, 3.2.2, 3.2.2.2 as well as Section 4.3.5.1 and Section 5.2.1. 1. Does the organization have a well define and documented PAM communication strategy; 2. Does the organization understand the communication and relationship dynamics between stakeholders within the PAM organization as well as across departmental barriers? 3. Do PAM staff understand and accept the PAMS? 4. Is there alignment between top executives view of the PAM strategy and the views of other organizational members; 5. Is there alignment between the various communication media being used in the organization i.e. formal communication such as meetings and written communications and informal communication such as "the grapevine"? 6. Is PAM communication mostly top-down, or does the organization actively attempt to solicit the views from all organizational staff members? 7. Are performance reports regularly distributed? 8. Do PAM staff understand the implications of performance reports?
Change Management	The questions and factors referred to below is based on the theoretical considerations discussed in Section 3.2.1 and Section 5.2.1. 1. Did the organization evaluate the organizational change readiness in the past 12 months? 2. Are PAM practitioners aware of any resistance to change that might exist within the organization? 3. Did the organization utilize any Change Management Tactics (CMT) in the past 12 months? 4. If yes, why was the specific CMT chosen?

Deadly Dectet Factor	Typical Screening questions and factors to consider
Consensus and Priorities	The questions and factors referred to below is based on the theoretical considerations discussed in Table 3.1, Table 3.2, Table 3.3 and Table 3.4 and discussed in detail Section 3.2.1, 3.2.2, 3.2.2.2 as well as Section 4.3.5.1 and Section 5.2.1. 1. Are there many competing priorities within the PAM organization? 2. Do decision makers use any form of decision support mechanism to assist them when priorities are determined? 3. Are the often debates on the allocation of scarce resources? 4. Are key decision makers in consensus on what the key PAM focus areas should be? 5. Are resources made available in line with the agreed priorities? 6. Is there regular conflict amongst members of the PAM organization? 7. Is there regular conflict btween members of the PAM organization and other departments? 8. Is there a culture of blame-shifting or does blame-shifting often occur? 9. Is there any evidence of an "us and them" culture?
Commitment	The questions and factors referred to below is based on the theoretical considerations discussed in Table 3.1, Table 3.3, Table 3.5 and Table 3.6 and discussed in detail Section 3.2.1, 3.2.2, 3.2.2.2 as well as Section 4.3.5.1 and Section 5.2.1. 1. Do staff members understand what is expected of them? 2. Do staff members have the necessary resources to do their work? 3. Do staff members receive regular feedback on their performance? 4. Are there opportunities for employees to grow and develop? 5. Does the organization allow flexibility regarding work–life balance? 6. Do staff members trust their senior leaders and do they have confidence in their ability to execute the strategy?

Figure 6.10: Action planning

6.4.4 Value Proposition

The outcome of the screening process is a report that is comparable to a pathology or radiology report. As in the case with a diagnostic report of a patient, the PAMSEEM screening report will empower decision makers to make informed decisions when developing action plans to address risk areas pro-actively.

6.5 Action Planning

> *It does not do to leave a live dragon out of your calculations, if you live near him.*
>
> Tolkien (1937), The Hobbit

Phase 3 of the PAMSEEM is the Action Planning phase. Based on the interpretation and recommendations made in the PAMSEF DDF report (Table 6.9) the organization need to develop and prioritize a number of Action Plans. Action planning within the context of the PAMSEEM is illustrated in Figure 6.10.

In Section 2.2.3 planning within the Contemporary Organization was compared to planning within the Bureaucratic Organization and the comparative summary developed by Liedtka (2001) was illustrated in Section 2.1. In the development of Action Plans to remove and manage PAMSE DDFs, practitioners and academics should take cognisance of these contemporary design principles.

In Table 6.11 an overview of the most important aspects involved during this phase is provided. All these aspects are discussed in more detail in the remainder of Section 6.5.

Table 6.11: Action Planning

Medical analogy	
CVD	**PAMSEF**
In the event that CVD has been diagnosed a patient treatment plan need to be developed. The following factors should be considered during the development of the plan: • The patients readiness to change; • The patients demographic characteristics; • The complexity of the treatment protocol; • The quality of the doctor/patient relationship; and • The communication of the plan.	The following factors should be considered during the development of the DDF Action Plan: • The organizational readiness to change; • Stakeholder characteristics and demographic profile; • The complexity of the proposed Action Plans; • The quality of manager/non-manager relationships; and • The effectiveness of existing communication methodologies.
Major decisions and theoretical grounding	
Decision: Action Plan prioritization.	**Description:** The most important decision during this phase relates to the prioritization of Action Plans. It is strongly recommended that Action Plans are developed to address all DDFs in order to gain an understanding of the relative impact and affordability. Based on this understanding decision makers should then employ methods to assist them to prioritize the implementation of these Action Plans.
Reference: Section 2.2.3 Section 3.2.1 Section 4.3.5	**Theoretical grounding:** Contemporary Action Planning design principles Assess organizational change readiness Prioritize Action Plans
Process flow	
Core Processes:	**Description:**

Step 1: Develop Action Plans	The development of action plans and interventions to address the risk areas identified during the screening process. The development of these action plans is a highly iterative process and a wide range of stakeholders are involved.
Step 2: Implement Action Plans	Implementation requires strategy consensus understanding and commitment from all stakeholders.
artefacts	
Reference:	**Artefact:**
Table 7.16	Example of DDF Action Plan
Value proposition	
The Action Planning process in itself often address fundamental factors causing PAMSEF such as lack of consensus, commitment and interdepartmental conflict.	

In the remainder of this section each one of the above aspects will be discussed in more detail. The importance of the theoretical grounding of the mechanism has been stated. Regular reference to work done in preceding chapters will thus be made in the following sections. In order to facilitate the flow of discussion these references will however be integrated in the text and will not be dealt with separately as was the case in the table above.

6.5.1 The Medical Analogy

Extensive research has been done on the development of patient treatment plans. It is not the purpose of this section to review the extensive BOK on patient treatment plans. The following general guidelines and principles medical practitioners are recommended to consider, when developing a patient treatment plan, were however found to be extremely applicable and useful[1] the purpose of this study . These principles and guidelines should also be considered by PAM practitioners during the development of Action Plans to address DDFs:

- Assess the patients readiness to change – Bender (2002), defines five stages of patient readiness to change. These five stages are illustrated in Table 6.12.

[1]It is important to note that is not and exhaustive list of guidelines and principles. These guidelines and principles were however found to be usefull for the purpose of this study.

- Consider the patients demographic characteristics – Age, gender, language ability and social class all have an impact on a patients interpretation and understanding of the Treatment Plan.
- Complex treatment protocols has high levels of non-adherence.
- Treatment compliance is better when the doctor/patient relationship good.
- Treatment compliance is better when Treatment Plans are well communicated and contextualized, i.e. when patients understand how the treatment protocol would influence their specific condition.

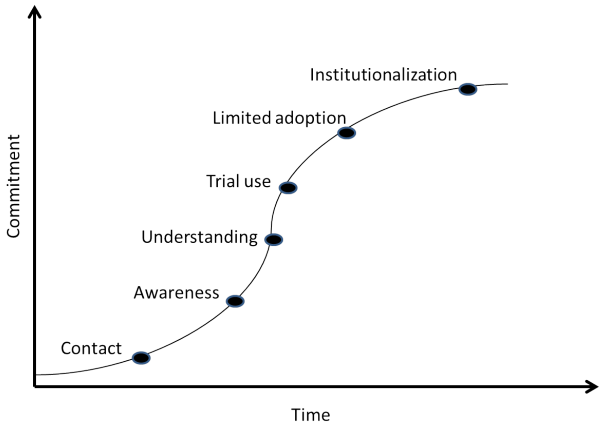
Table 6.12: The five stages of patient readiness to change

Stage	**Description**
1. Precontemplation	Patient is unaware of or minimizes health problems.
2. Contemplation	Patient has some awareness of health risks and the need to change behaviors but is ambivalent.
3. Preparation	Patient is concerned about health, sees benefits of changing behaviors, begins to take steps toward change.
4. Action	Patient changes behavior to achieve a goal.
5. Maintenance	Patient continues with behaviors to maintain health.

During the development of Action Plans to address the DDFs of PAM practitioners should consider the following guidlines:

- Assess organizations readiness to change. In Section 3.2.1 the change readiness curve recommended by Stanford (2007), for plotting change readiness was illustrated. The "Change readiness curve" is reproduced in Figure 6.11 for ease for reference. The Figure illustrates where people typically are in relation to change. Stakeholders affected by change have to reach the top of the change curve before change is successfully embedded. In the same way medical practitioners should understand and take cognisance of the patients readiness to the change, PAM practitioners should understand and take cognisance of organizational stakeholders readiness to change when Action Plans are being developed. Change readiness assessments identify possible barriers, enablers and risks, which in turn helps identify where to focus change implementation activities and resources.
- Consider the stakeholder demographics – In the same was medical practitioners should not treat all patients in the same way, PAM practitioners should consider stakeholder demographics during the development of Action Plans. Stakeholder diversity often complicates Action Plan implementation, and practitioners should be aware of and consider this reality during the conception plans;
- In line with the observations regarding change readiness and stakeholder demographics PAM practitioners should also take cognisance of the importance of sim-

Figure 6.11: Change readiness curve



Reproduced from Stanford (2007)

plicity during the development of Action Plans. Highly complex plans have a far lower probability of being successfully implemented (especially within the context of a diverse group of stakehoders);

- Action Plans have a far higher probability of succeeding if the relationship between managers and non-managers and are sound. Unhealthy relationships are characterized by mistrust and suspicion, and complicates the implementation of Action Plans;

- In line with the observation regarding Action Plan complexity, understanding and acceptance of the Action Plan intention and purpose are critical pre-requisites for effective organization change to take place. Most traditional organizational communication efforts only create awareness, and PAM practitioners should investigate and utilize context appropriate and creative communication methods to ensure understanding and acceptance of Action Plan intentions.

6.5.2 Action Planning artefacts

Most PAMSEEM artefacts has been introduced in the preceding sections. A number of Action Planning templates are used within organizations. For the sake of completeness the following typical Action Planning template is however presented in Table 7.16:

Table 6.13: Example of a DDF Action Plan

Objective: To address the in-efficiencies in the current PAM Communication process				
Step no.	**Description**	**Responsible**	**Deadline**	**KPI**
Step 1	Analyze existing communication process in detail	XYZ Consult	August 2015	Completed communication audit
Step 2	Present findings of audit to the steering committee	XYZ Consult	Sept 2015	
Step 3	Develop Communication campaign to ensure awareness, understanding and acceptance of the PAMS	Steering Committee	Oct 2015	Evaluation of impact of campaign
Financial Impact				
Step no.		**Cost**		
Step 1		R250 000		
Step 2		R250 000		
Step 3		No Cost		
Step 4		R250 000		
Total		R750 000		

6.5.3 Decisions and process flow

During the operationalization of Phase 3 of the PAMSEEM and in line with Figure 6.4, a number of decisions should be made, and implementation steps completed. These decisions as well as the implementation steps are discussed in more detail in this section. In order to ensure the academic integrity of the mechanism regular reference will be made to work done in the preceding chapters.

Major Decisions: The most important decision during this phase is relates to the prioritization of Action Plans. The Screening and Detection phase might reveal a number of potential problem areas, it would be unrealistic and unfeasible to address all these factors at once. It is strongly recommended that Action Plans are developed to address all DDFs in order to gain an understanding of the relative impact and affordability. In addition hereto it is critically important that the PAMSEEM steering committee should also consider other change and improvement initiatives and interventions within the organization. The steering committee should ensure that PAMSEEM interventions are aligned Based on this understanding decision makers should then employ methods to assist them to prioritize the implementation of these Action Plans. The method introduced by Bam & Vlok (2014) and discussed in Section 4.3.5 could be considered as a useful aid in this regard.

Core Processes: Phase 3 requires the completion of the following core processes or steps:

- **Step 1 – Develop Action Plans and interventions:** The development of these action plans is a highly iterative process and a wide range of stakeholders are involved. Stakeholders are required to identify stretch targets; and

- **Step 2 – Implement Action Plans:** – In Section 3.2.1 the importance of consensus during the formulation of strategies and action plans were illustrated. Specific reference was made to the definition of strategy consensus formulated by Floyd & Wooldridge (1992). In their definition they illustrate that strategic consensus is a function of both understanding and commitment. "Strong consensus" is according to them only possible if stakeholders have both an in-depth understanding as well as strong commitment to identified strategy. The formulation of action plans based on the results of a dedicated screening process ensures consensus among stakeholders. The data gathering methodology used during the screening process as well as the formulation of action plans ensure that stakeholders have an in-depth understanding of the problem areas and the joint formulation of the SoD ensures strong commitment.

  The involvement of a wide variety of stakeholders during this phase also give the PAMSEEM owner and steering committee access to a vast range of experience and knowledge (both explicit and tacit).

The Value proposition of the Action Planning phase is stated in the next section.

6.5.4 Value proposition

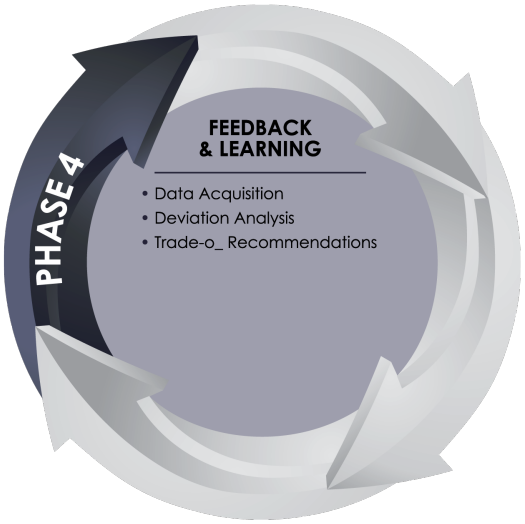
The process is designed and deployed in such a manner that stakeholder consensus and commitment is already confirmed during the formulation and prioritization of action plans. The action plan objectives and stretch targets become the accountability of the total cross-functional PAMSEEM implementation team. The achievement of objectives are also incentivized on a cross-functional and cross-departmental basis and this strongly contributes to the break down of organizational silos. The Action Planning process in itself thus often address fundamental factors causing PAMSEF such as lack of consensus, commitment and interdepartmental conflict.

6.6 Learning and Feedback

> *"Business and human endeavors are systems ... we tend to focus on snapshots of isolated parts of the system. And wonder why our deepest problems never get solved."*
>
> Senge (2014), The Fifth Discipline

The final (ongoing and iterative) phase of the PAMSEEM is Learning and Feedback. Although this phase is presented as the fourth step in a series of activities it should not be construed as such. Learning and Feedback within the context of the PAMSEEM is illustrated in Figure 6.12.

Figure 6.12: Learning and Feedback



As indicated in Section 2.2.2 strategies and action plans within the Bureaucratic Organization were designed and implemented as part of a linear process. Feedback and learning was, within this context, thus presented as a final step and often treated as an "after thought" or in many instances not considered at all. In Section 2.4.1 this linear process was described as a classical example of what Argyris (1977), Argyris (1991), Senge & Suzuki (1994) and Senge (2014) refers to as single-loop learning. In the discussion it was noted that Argyris (1977) already in 1977 made a distinction between single-loop learning and double-loop learning. This distinction had a significant impact on the way in which theorists and organizations conceptualized learning. It was illustrated that single-loop learning occurs when a mismatch is detected and corrected without changing the underlying values and status quo that governs the behaviours. Double-loop learning requires decision makers to question the underlying values and principles and requires the development of new routines and practices based on the new understanding of the universe. Argyris's ideas regarding double-loop learning have been applied by many theorists including Senge & Suzuki (1994) and Kaplan & Norton (1996b). Within the constraints of the Bureaucratic Organization (BO) the application of his ideas were however less effective. Double-loop learning have however become part of the design principles of many contemporary organizational processes, and is indeed embraced in the PAMSEEM. With single-loop learning the objectives are never questioned after they have been formulated, and all deviations from the planned trajectory is treated as failures.

Feedback and learning is however a continuous process and within the context of the Contemporary Organization the PAMSEEM implementation team should continuously be vigilant in the identification of signs that might indicate or require not only a change of plans but a fundamental rethink of the underlying objectives and principles.

The PAMSEEM thus embraces the principles of double-loop learning and dialogue[1].

The process thus requires stakeholders to continuously engage in dialogue not only on results being achieved or not, but on understanding the fundamental principles and values that lead to the formulation of the Physical Asset Management Strategy in the first instance. Only once the organization has acquired the discipline of double-loop learning and the skill to engage in continuous dialogue effective strategy feedback and learning and ultimately Strategy Execution is possible.

In Table 6.14 an overview of the most important aspects involved during the Learning and Feedback phase is provided. All these aspects are discussed in more detail in the remainder of Section 6.6.

Table 6.14: Learning and Feedback

Medical analogy	
CVD	**PAMSEF**
• Patients that understand their condition and are committed to learn and change their behaviour have a better prognosis; • Learning and training are important factors to enable behaviour and life-style change; and • Behaviour change in combination with medication is far more effective than medication on its own.	• Organizations that understand the causes and implications of PAMSEF and who are committed to learn and change have a far better PAMSE prognosis; and • The implementation of complex action plans are not the only way to treat or prevent PAMSEF
Major decisions and theoretical grounding	
Decisions:	**Description:**
Embrace continuous learning.	The most important decision the PAM organization can take is to embrace the principles of continuous learning.
Reference	**Theoretical grounding:**
Section 2.2.2	Strategy in the Contemporary Organization is not linear

[1]Senge & Suzuki (1994) defines dialogue as:

> *"...the capacity of members of a team to suspend assumptions and enter into a genuine thinking together..."*

.

According to Senge & Suzuki (1994) for the ancient Greeks *"dia-logos"* meant a free-flowing of meaning through a group, allowing the group to discover insights not attainable individually.

Section 2.4.1	Single feedback learning occurs when a mismatch or substandard performance is detected and actions are put in place to correct these.
Section 2.4.1	Double feedback learning requires decision makers to question the underlying princiles and values
Process flow	
Core Processes:	**Description:**
Step 1: Data Acquisition	Learning and feedback requires access to data. Collecting data on a continuous basis can be extremely cumbersome and attempts should be made to automate the process as far as possible.
Step 2: Deviation Analysis	Ongoing data analysis is required to analyze trends and possible relations between variables
Step 3: Trade-off Recommendations	Based on the results of the Deviation Analysis the organization should prepare Trade-off Recommendations. These recommendations can either be to: • Continue and improve; • Re-align the strategy; • Redesign the strategy.
Value proposition	
In addition to the fact that the completion of both these processes are essential steps in the definition of the PAMSEEM Scope of Work (SoW), these processes plays in major role in raising awareness levels.	

6.6.1 Medical Analogy

Extensive research has been done over the past decades to assess the long term health impact of effective behavioural therapy as opposed to clinical theraphy in CVD patients. It is not the purpose of this study to review the findings of all these studies in detail. The findings of a study done by Sjöström *et al.* (1999) however provide a useful framework to illustrate how patients at risk for CVD can be influenced through learning and training of skills to enable the behavioural and lifestyle changes required for control of weight and blood pressure.

Several multifactorial, lifestyle risk-reduction trials, in which counseling has been cen-

tral regarding a healthful diet and regular physical exercise, have clearly demonstrated that the atherosclerotic processes, with or without medical therapy, can be slowed, arrested, and even reversed. In one of these trials referred to by Sjöström *et al.* (1999) 18 heart disease patients followed a very-low-fat plant-based diet and, where needed, received hypolipidemic medication. Eleven of the patients had follow-up angiograms after five year, and among these patients 11 out of 25 atherosclerotic lesions had regressed and 14 had been arrested. No patient had any evidence of new infarctions or of clinical progression. In contrast, patients treated conventionally had experienced 49 cardiovascular events during the preceeding eight years. This illustrates:

- The impact knowledge of the condition has on the outcome of the treatment protocol;
- The importance of learning and training of skills to enable behaviour and life-style change;
- The importance of a non-pharmacological approach to prevention and treatment of cardiovascular disease;

In the same way stakeholders in the PAM organization need to:

- Understand the causes and implications of PAMSEF;
- Be committed to continuously learn more about DDFs'
- Understand that the implementation of complex action plans (read patient treatment protocols) are not the only way to treat or prevent PAMSEF. Knowledge of the condition and a commitment to question fundamental assumptions around not only the impact of the chosen action plans but the PAMS *per se* will have a significant impact on successful PAMSE

6.6.2 Decisions and process flow

During the operationalization of Phase 4 of the PAMSEEM and in line with Figure 6.4, a number of implementation steps need to be completed. In order to ensure the academic integrity of the mechanism regular reference will be made to work done in the preceding chapters.

- **Step 1 – Data Acquisitions:** – Collecting performance data can be incredibly difficult and cumbersome, not least because it often exists in different forms and formats around the organization. This problem is even more severe when traditional functional boundaries are crossed. These separate data basis all contain data about how well the organization is performing, yet rarely are these data sets collated into a single integrated set so that some broad based performance analysis can be carried out.

- **Step 2 – Deviation Analysis:** – Following the acquisition of performance data, the data now needs to be analyzed, performance trends identified and possible relationships between variables established. The main purpose of this effort is to enhance the organizations knowledge and understanding of "the problem". Managers often concentrate on the results that will get them immediate reward, thus sacrificing the long-term health of the business for short–term gain.

  In order to prevent the above it is recommended that system dynamics principles are applied. This refers to a methodology for studying and managing complex feedback systems, such as one often finds in business. Feedback is the differentiating descriptor here. Feedback refers to the situation of X affecting Y and Y in turn affecting X perhaps through a chain of causes and effects. One cannot study the link between X and Y and, independently, the link between Y and X and predict how the system will behave. Only the study of the whole system as a feedback system will lead to correct analysis.

  The use of correlation and regression analysis techniques in order to establish and describe relationships between variables are important. The following three basic goals should be considered when studying relationships between variables:

  1. Describe and understand the relationship;
  2. Forecast and predict a new observation; and
  3. Adjust and control the process.

- **Step 3 –Trade-off Recommendations:** – Based on the results of the Deviation Analysis, the organization typically prepares Trade-off Recommendations. Decision makers should consider the organizations strategy, its objectives and relationship with major stakeholders (including shareholders, customers, employees, suppliers and regulators) when preparing the trade-off report. Specific corrective action can then be taken on the basis of relevant and accurate information. These actions might include, but is not limited to the following:

  1. Continue and Improve – The correlation analysis might prove that a positive relationship between the current strategy and the current objectives exist. Based on this finding the trade-off recommendation to the organization might thus be to continue with the execution of its current strategy and objectives and to only embark on a program of continuous improvement typically in line with the principals of Total Quality Management (TQM).
  2. Strategic Re-alignment – The correlation analysis might however establish a negative relationship between the strategy and objectives or between individual objectives. The regression analysis might predict that if the organization should continue to implement those strategies and objectives sub-optimal results will be achieved. Based on these finding the trade-off recommendation to the organization might thus be to re-align their objectives and action plans.

3. Strategy Redesign –Based on an assessment of the current business environment, the organizations current strategy, its objectives and relationship with major stakeholders as well as the results of the correlation and regression analysis the trade-off recommendation might in the final instance be to redesign and rethink the organizational strategy and objectives in total.

In the next section the Value proposition of the Learning and Feedback mechanism will be presented.

6.6.3 Value proposition

The Learning and Feedback process requires stakeholders to continuously engage in dialogue not only on results being achieved or not, but on understanding the fundamental principles and values that lead to the formulation of the Physical Asset Management Strategy in the first instance. Only once the organization has acquired the discipline of double-loop learning and the skill to engage in continuous dialogue effective strategy feedback and learning and ultimately Strategy Execution is possible.

6.7 Conclusion

In this chapter a model to assist practitioners with the early detection and prevention of PAMSEF was presented. It was shown that the PAMSEEM is essentially a double–loop feedback system consisting of four iterative phases, four major decisions and a number of implementation processes and steps. The phases decisions and processes were introduced in Sections 6.1 and 6.2. An abridged version of the phases, decisions and processes involved in the use of the mechanism was presented in Table 6.1 and is reproduced in Table 6.15 for ease of reference.

Table 6.15: Abridged introduction to the PAMSEEM

Phase	Major decisions	Processes
Phase 1: Awareness	The most important decision during the Awareness phase is the decision regarding the need to optimize.	• Step 1 – Constitute steering committee; • Step 2 – Evaluate PAMS; • Step 3 – Create Statement of Direction (SoD); • Step 4 – Introduce generic PAMSEEM; • Step 6 – Develop PAMSE calender; and • Step 7 – Continuous stakeholder communication.
Phase 2: Screening	The most important decision during the Screening phase is the acceptance of the results of the screening process.	• Step 1 – Contextualize the generic screening model; • Step 2 – Gather data; • Step 3 – Complete the model and calculate scores; • Step 4 – Interpret the results; and • Step 5 – Present the results.
Phase 3: Action Planning	The most important decision during the Action Planning phase relates to the prioritization of Action Plans. A number of methods to assist decision makers during the prioritization process is introduced.	• Step 1 – Develop Action Plans; and • Step 2 – Implement Action Plans.
Phase 4: Learning and Feedback	The most importance decision the PAM organization can take is to embrace the principles of continuous learning.	• Step 1 – Data acquisition; • Step 2 – Data analysis; and • Step 3 – Trade-off recommendations

It was noted that "Enforcement" within the context of this mechanism refers to the discipline of continuous detection, prevention and management of the underlying causes of PAMSEF. In the presentation and explanation the remarkable similarities between the characteristics of the screening and management of Cardio Vascular Diseases (CVD)s and Strategy Execution Failure (SEF) was highlighted and the intuitiveness of the former provided a great platform to explain the latter. In the presentation of the model a number of references was made to the screening and management of CVDs.

The PAMSEEM is is not only a theoretical model to be used within the confines of

a laboratory but a practical mechanism that should ultimately become part of the PAM organization's standard operations procedures and DNA. In the presentation of the model a balance thus had to be struck between two seemingly opposing objectives:

1. The postulation of a theoretical framework, with high levels of academic integrity; and
2. The presentation of a mechanism with practical value that will make a contribution within PAM organization and that would assist the PAM practitioners with the execution of the PAMS.

In order to achieve the former objective and to ensure the theoretical grounding of the mechanism regular reference was made to work done in preceding chapters. In order to achieve the latter objective the practical operationalization of each phase was discussed Sections 6.3, 6.4, 6.5 and 6.6.

Each one of these sections were concluded with the presentation of a value proposition. In Table 6.16 these value propositions are summarized. Although the implementation of the PAMSEEM in its totality is strongly recommended an analysis of Table 6.16 should clearly indicate that each one of these phases has value in its own right.

Table 6.16: Abridged introduction to the PAMSEEM

Phase	**Value proposition**
Phase 1: Awareness	During Phase 1 PAM stakeholders are introduced to both the potential negative impact of PAMSEF and the factors that typically contribute and lead to SEF. An understanding of both these realities are essential steps in the definition of the PAMSEEM Scope of Work (SoW), and plays in major role in raising awareness levels. Awareness in itself as illustrated by the research done by Mosca *et al.* (2000), and referred to in Section 6.3.1 plays a critical role in prevention.
Phase 2: Screening and decection	The outcome of the screening process is a report that is comparable to a pathology or radiology report. As in the case with a diagnostic report of a patient, the PAMSEEM screening report will empower decision makers to make informed decisions when developing action plans to address risk areas pro-actively.
Phase 3: Action planning	The process is designed and deployed in such a manner that stakeholder consensus and commitment is already confirmed during the formulation and prioritization of action plans. The Action Planning process in itself thus often address fundamental factors causing PAMSEF such as lack of consensus, commitment and interdepartmental conflict.

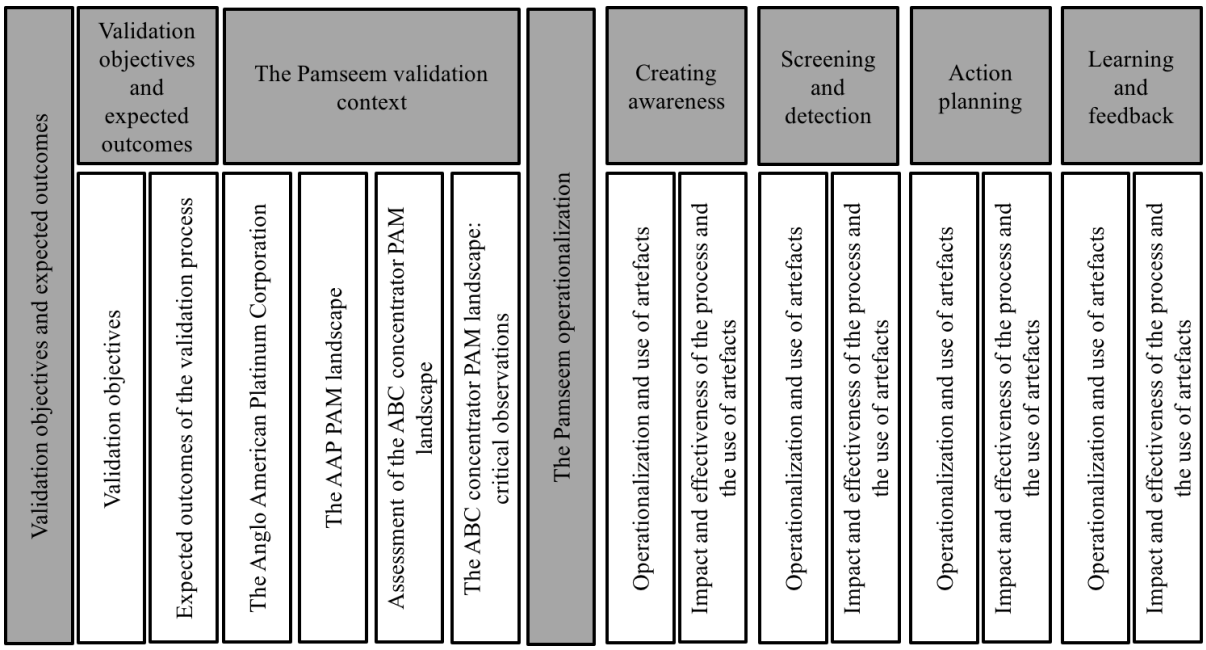
Phase	Value proposition
Phase 4: Learning and feedback	The Learning and Feedback process requires stakeholders to continuously engage in dialogue not only on results being achieved or not, but on understanding the fundamental principles and values that lead to the formulation of the Physical Asset Management Strategy in the first instance. Only once the organization has acquired the discipline of double-loop learning and the skill to engage in continuous dialogue effective strategy feedback and learning and ultimately Strategy Execution is possible.

In the next chapter the implementation of the PAMSEEM within the context of the largest platinum producer in the world is presented. The academic integrity as well as the practical value of the mechanism is validated in the presentation.

Chapter 7

PAMSEEM validation within the context of a highly PA dependent organization

Figure 7.1: Chapter 7 outline



The purpose of this chapter is to present the methodology and results of the PAMSEEM validation process. The chapter outline is presented in Figure 7.1.

7.1 Validation design: philosophy and methodology

The validation of new methods and models are important for the continuing advancement of both theory and professional engineering practice. Model validation can according to Frey & Dym (2006) be viewed as a specialized topic within the epistemology[1], and they identify four prominent views on the justification of knowledge claims:

- Foundationalism – the view that some instances of knowledge are basic and that it is possible to justify or validate new instances by relating them to basic beliefs (e.g. by deduction from axioms);
- Relativism – the view that knowledge cannot be validated in an objective way and that subjective preferences or fraternal behaviour among scientists must be considered as part of the validation process;
- Naturalistic epsitemology – the view that promotes the empirical study of how subjects convert data into theories; and
- Epistemology of practice – the view that skilled practitioners often rely on tacit knowledge that cannot be easily codified when new models and methods are validated.

Schön (1983) conducted field studies of engineers and other professionals and observed that skilled practitioners often relied on tacit knowledge that cannot be easily codified. Argyris (1991) refers to the set of tacit knowledge driving the professionals work as "theory–in–action".

For the purpose of this study the focus will fall on the validation methodologies used as part of the epistemology of practice. A detailed discussion on the roots and development of the epistemology of practice falls outside the scope of this study, but the following suggested validation principles, methodologies and requirements noted by Argyris (1977) in his seminal work are considered specifically:

- Testability of the new theory or model:
  - A specific situation in which the theory or model can be applied or implemented, needs to be specified. The implication is thus that an environment that is conducive to validation need to be established.
  - The desired results of the application of the theory or the implementation of the model, can be defined;
  - The action through which the impact of the theory or the application of the model will be evaluated, can be described; and

[1]The branch of philosophy concerned with the nature of knowledge, the justification of knowledge and the nature of rationality.

- Internal consistency of the new theory or model;
- Congruence between the new theory or model and espoused theory;
- Effectiveness of the the new theory or model – i.e what will constitute successful validation.

Epistemology of practice thus often requires the researcher to validate models and theories within the context of a single environment. The principles and practices involved in case study research thus also has to be considered as part of the validation design process and the following aspects are noted specifically.

A case study is according to Hussey & Hussey (1997) an extensive examination of a single instance or phenomenon of interest and is an example of the phenomenological methodology. Eisenhardt (1989b) refers to case study research as:

> *"...a research study which focuses on understanding the dynamics present within a single setting..."*

Yin (2013) identifies the following characteristics of case study research:

- The research aims not only to explore certain phenomena, but to understand them within a certain context;
- The research typically does not commence with a set of questions or notations about the limits within which the study will take place; and
- The research uses multiple methods of collecting data which may be both qualitative and quantitative. This is confirmed by Eisenhardt (1989b) that states that case study researchers typically combine multiple data collection methods. Denzin (2012) describes this approach as triangulation. He indicates that the use of different data collection methodologies to study the same phenomenon (in this instance the effectiveness of the PAMSEEM), should if their conclusion are the same lead to greater validity and reliability and internal consistency than a single data collection approach.

These characteristics are however according to Hussey & Hussey (1997) open to debate and a more positivistic research approach might demand a stronger theoretical foundation and the definition of specific research questions.

For the purpose of this study a less positivistic approach is however followed. During the validation process the aim is to gain an in-depth understanding of all possible dynamics, that might have had an impact on the use and effectiveness of the PAMSEEM.

All these aspects were considered during the PAMSEEM validation design process and Table 7.1 provides and overview of the validation process.

Table 7.1: The PAMSEEM validation process

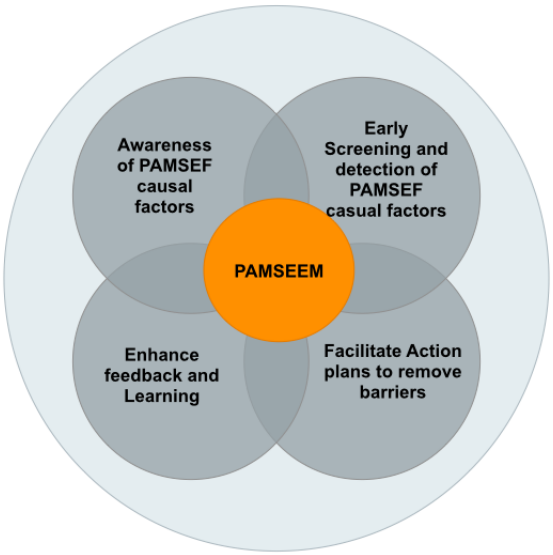
Validation step	Validation aspect	Description
Confirmation of validation objectives	• Testability	In Section 7.2 the focus falls on: 1. The confirmation of the validation objectives; and 2. The expected outcomes of the validation process.
Description of the validation context	• Testability	In Section 7.3 the focus falls on mainly four aspects: 1. A brief overview of the organization in which the PAMSEEM operationalization was done; 2. A brief overview of the PAM landscape within the chosen organization; and 3. A brief overview of the process that was followed to gain an in-depth understanding of the PAM context, processes and systems, and the steps that were taken to prepare the organization for the PAMSEEM deployment. 4. A brief overview of the most important observations that were made during the PAM assessment that were conducted in an attempt to gain an in-depth understanding of the PAM landscape within the chosen validation context.
Description of the PAMSEEM operationalization	• Internal consistency; • Theoretical congruence; • Effectiveness	In Sections 7.5, 7.6, 7.7, 7.8 the focus falls on mainly two aspects: 1. A detailed description of the deployment of each one of the PAMSEEM phases and the use of artefacts introduced and described in Chapter 6, within the context of a highly PA intensive organization; and 2. A discussion on the impact the deployment of these phases and use of these artefacts had on the achievement of the study objectives as described in Chapter 1 and confirmed in Section 7.2.

7.2 Validation objectives and expected outcomes

In this section the focus falls on the following validation aspects:

- The validation objectives; and
- The expected outcomes of the validation process;

Figure 7.2: The purpose of PAMSEEM



Each one of these aspects are described in more detail in the following two sections.

7.2.1 The validation objectives

The validation objectives are the following:

1. To complete the validation process and to comply with all generally accepted academic standards and requirements as briefly referred to in Section 7.1;
2. To describe the PAMSEEM operationalization process and the use of recommended artefacts;
3. To illustrate in the most effective way possible that the PAMSEEM objectives were achieved during the operationalization process. These objectives were described in the introduction to Chapter 6 and was illustrated in Figure 6.3 and is reproduced in Figure 7.2 for ease of reference.

The expected outcomes of the validation process will be described in the next section.

7.2.2 Expected outcomes of the validation process

Unlike empirical research where it would be possible to quantify the extent to which validation objectives are met, the nature of the validation objectives of this study require

a more qualitative approach when the achievement of validation objectives are evaluated. For this reason the observations of the research team as well as feedback from senior organizational leadership are very important. In the light of this reality it is expected that the effective operationalization of the PAMSEEM within the chosen validation context will:

1. Contribute to organizational awareness regarding factors that lead to PAMSEF –

   The evaluation of the achievement of this validation objective is however particularly difficult and complicated by the following factors:

   - It was not possible to establish an experimental control environment prior to the operationalization of the PAMSEEM within the chosen validation context;
   - A qualitative or quantitative yard stick for the measurement of organizational awareness of PAMSEF causal factors did not exist prior to the study and it was not the purpose of the study to develop such a yard stick[1]; and
   - The implication of the above is that it is impossible to frame (qualitatively or quantitatively) the impact the operationalization of the PAMSEEM had on increased PAMSEF casual factor awareness levels. Anecdotal evidence on increased awareness levels will indeed be provided, but the inability to frame these levels are indeed recognized as a limitation.

2. Lead to the detection the DDFs that cause PAMSEF;
3. Lead to the development of action plans aimed at addressing these factors; and
4. Lead to the creation of an PAM organization that understand and apply the principles of single-loop and double-loop learning.

In the next section the validation context is described in more detail.

7.3 The PAMSEEM validation context

The Anglo American Corporation (AAC) is a global and diversified mining business with operations, growth projects and exploration, and marketing activities extending across southern Africa, South America, Australia, North America, Asia and Europe. The AAC have established relationships with a number of academic and research institutions. The Asset Care Research Group (ACRG) at the University of Stellenbosch is one of these institutions.

[1]It is strongly recommended in Chapter 8 that the development of such a yard stick should form part of the objectives of future studies in this field.

In line with the established relationship that exist between the AAC and the Asset Care Research Group (ACRG) at the University of Stellenbosch the purpose of the study was explained to senior decision makers within AAP during May 2014. These decision makers immediately acknowledged the PAMSE challenges experienced by AAC operations, and confirmed the AAC's commitment to assist with the development and validation of the PAMSEEM.

Amongst other holdings the AAC has a 77.3% stake in Anglo American Platinum (AAP) and the AAC leadership recommended that the PAMSEEM should be validated within the context of one of the AAP operations.

During June 2014 the Engineering Manager at one of the AAP concentrators was approached. The purpose of the study was explained to him and he also immediately expressed interest in assisting with the development and validation of the PAMSEEM. In accordance with the research agreement entered into between the University of Stellenboch and the concentrator the identities of the BU as well as critical stakeholders will not be revealed – reference will only be made to ABC concentrator. In addition hereto some of the less important facts and characteristics of this concentrator was deliberately changed in an attempt to protect the identity of both the organizations and the stakeholders that formed part of this study.

In line with the characteristics of case study research identified by Yin (2013) and referred to in Section 7.1, the aim of case study research is not only to explore certain phenomena, but to understand them within a certain context. For this reason it was important to gain an in-depth understanding of all PAM practices within the context of the ABC concentrator.

In order to achieve this objective it was agreed that a PAM assessment, during which all aspects of the PAM practices and principles were evaluated and burning platforms identified, had to be conducted prior to the operationalization of the PAMSEEM.

After agreement regarding the research mandate and scope were reached a research project plan was developed. An abridged version of the agreed project plan and time table is presented in Table 7.2.

Table 7.2: PAMSEEM operationalization and validation project plan

Project Phase	Description	Duration	Date
	PAM assessment		
Stakeholder engagement	Explain the purpose of the total project to all relevant stakeholders.	1 Day	4 July 2014
Preparation to enter the field	Finalize assessment themes and communicate them to the ABC concentrator management team.	2 Weeks	18 July 2014
Conduct PAM assessment	Evaluate all existing PAM strategies, policies and practices in detail.	2 Weeks	1 August 2014

Project Phase	Description	Duration	Date
Data analysis	Analyze all data gathered during the assessment phase by means of inductive abstraction and generalization.	2 Weeks	15 August 2014
Report compilation	Compile a report describing the most important observations of the PAM assessment. Although not the sole purpose of the assessment recommendations will be included in the report.	2 Weeks	29 August 2014
Feedback	Presentation of observations and recommendations to all stakeholders.	1 Day	12 September 2014
	PAMSEEM operationalization		
Phase 1: Awareness	Introduce PAM stakeholders to both the potential negative impact of PAMSEF and the factors that typically contribute and lead to SEF.	1 Week	26 September 2014
Phase 2: Screening and detection	Introduced all PAMSEEM screening and decection artefacts and screen for PAMSEF casual factors. Develop PAMSEF DDF report, and present report to steering commitee.	4 Weeks	24 October 2014
Phase 3: Action planning.	Develop action plans for all potential risk areas and prioritize the implementation.	3 Weeks	14 November 2014
Phase 4: Learning and feedback	The Learning and Feedback process requires stakeholders to continuously engage in dialogue not only on results being achieved or not, but on understanding the fundamental principles and values that lead to the formulation of the Physical Asset Management Strategy in the first instance.	Ongoing	Ongoing

A group of five highly qualified researchers were identified to assist with both the PAM assessment and validation process. The research team is presented in Table 7.3. Apart from the author of this study the names of other team members are not revealed.

Table 7.3: The ABC concentrator research team

Researcher	Qualification
Johann Stimie	MBL (Unisa), Masters in Industrial Sociology (UP), BA (Political Sciences)
Field worker 1	PhD (Industrial Eng), M.Eng. (Mech. Eng.), Pr.Eng.
Field worker 2	B. Eng (Mech)
Field worker 3	B.Eng (Mech)
Field worker 4	B. Eng (Chem)

As can be deducted from the above project plan a period of nearly 10 months lapsed between the completion of Phase 3 of the PAMSEEM operationalization and the writing of thus document. The reason for this is two-fold:

1. Enough time had to be allowed for the actions recommended and implemented to take effect; and
2. The sheer volume of the work involved in documenting the operationalization process and analyzing its impact, demanded a considerable amount of time and effort.

In the next sections a brief overview of the AAP Corporation as well as the AAP PAM landscape will be provided, whereafter the PAM assessment methodolology and most important observations will be presented in order to assist the reader to also gain an in-depth understanding of the PAMSEEM validation context. The unabridged version of the PAM Assessment Report (PAR) is presented in Appendix A.

7.3.1 The AAP Corporation

AAP is the world's leading primary producer of Platinum Group Metals (PGM)s. The company is listed on the Johannesburg Stock Exchange (JSE) and has its headquarters in Johannesburg, South Africa.

The company has sales and marketing offices located in London and Singapore as well as Johannesburg. The group provide a complete resource–to–market service, supplying a network of global customers with a range of mined, recycled and traded products. Their business is at the heart of the broader South African economic and social landscape and they have stated their commitment to the creation of a safe, sustainable, competitive and profitable business that benefits South Africa and its communities, their employees and their shareholders.

AAP operates across the entire value chain to produce the complete range of PGMs including platinum, palladium, rhodium, iridium, ruthenium and osmium, with different sites dedicated to each stage. High profile uses of PGMs include jewellery, auto catalytic converters, fuel cells, air and water purification units, heart pacemakers, computer screens, hard disk and fertilizers. In recent years the high value of PGMs has seen platinum become a prime investment commodity alongside gold.

AAP operations consist of mainly four operational areas:

1. Surface exploration – During 2014 AAP were involved in surface exploration projects at seven of their existing mining operations and 15 green field prospects;
2. Mining – The company currently manage and operate eight of their own mines and is involved in the management and operation of an additional seven joint venture mining operations;

3. Concentrating – AAP owns, manage and operate 12 platinum concentrator plants; and
4. Smelting – The company operate and manage four smelting furnaces, one slag cleaning furnace and two converters.

Table 7.4: AAP characteristics and results

Financial capital	• The company reinvested R4 943 billion in 2014. • R12,304 million was paid to salaries, wages and other benefits, net of tax; • R3,736 million was paid to taxation
Human and intellectual capital	The company employees 49 763 appropriately qualified and trained employees. The collective knowledge and research enables the company to reach its strategic goals. 4.9% (R602 million) of the total payroll was spent on training and development during 2014.
Natural capital	Mineral resources, surface land, water and energy are critical natural capital components required to sustain the business. 205.3 4E Moz Ore Reserves and 913.6 4E Moz Ore Resources.
Manufactured capital	Investment in engineering and technical solutions to reduce risk and increase efficiency. Management systems in place to manage hazards and risk. Capital expenditure was R6.9 billion during the year 2014.
Total refined production	• Platinum 1,889.5 Moz • Palladium 1,225.4 Moz • Rhodium 229.4 Moz • Nickel 28.2 tonnes • Copper 18.7 tonnes
Social Capital	Society needs PGMs for various industrial, environmental and jewellery applications. Society ultimately gives the Company its license to operate. The company spend R236 million on community development during 2014. • Public healthcare (24,586 people received primary healthcare by company-funded mobile clinics); • Education (bursaries and graduate in-training programmes were provided to 451 people); • Adult Basic Education and Training (ABET) was provided to 700 employees, 39 contractors and 198 community members; and • Infrastructure development (1,300 employee houses built to date).

Net Sales Revenue (2014)	R55,6 billion
Operating Profit (2014)	R843 million

"The AAP 2014 annual report."

Some of the companies most important characteristics as well as 2014 performances results are illustrated in Table 7.4.

7.3.2 The AAP PAM landscape

It is not the purpose of this study or indeed the PAMSEEM to make any value judgement on the validity or content of an organizations PAM philosophy, Physical Asset Management Strategy or PAM practices. In order to understand the context within which the PAMSEEM was validated the following overview of the AAP PAM landscape is however provided.

As part of the AAC technical strategy, a Group Technical Standards Board was established in 2010. The board has facilitated the development of standards in conjunction with all stakeholders. The Group Mining and Technology (GMT) function of the Anglo American Corporation (AAC) has developed an Asset Management Standard (ASMS)[1] referred to as the Anglo American Group Technical Standards 20 (AA GTS 20), targeting the production value chain, and focusing on the management of physical assets of its operations and subsidiaries (including AAP), over its complete life-cycle.

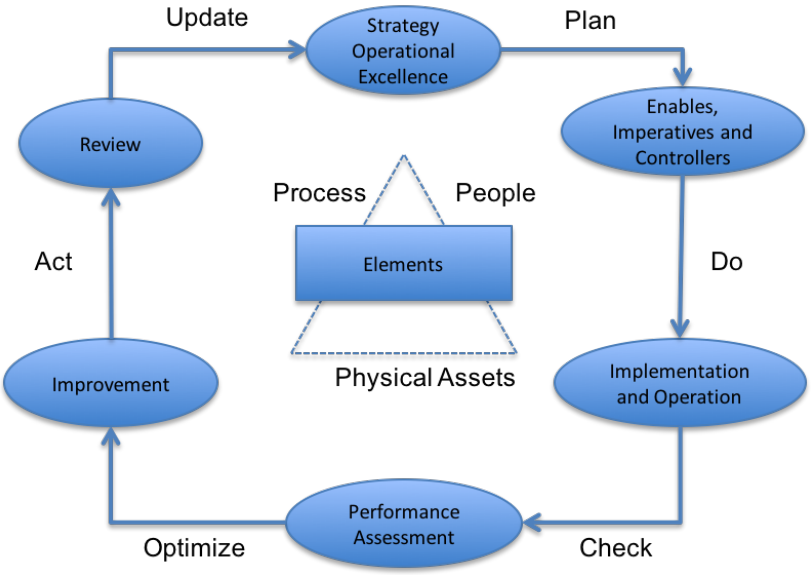
The AA GTS 20 provides guidelines for Business Units (BU)s to add value through waste reduction, cost cutting, time saving and efficiency improvements. These activities span the entire business, and require benchmarking the performance of all assets and processes, from natural resources and capital to processes and skills.

The AA GTS 20 integrates minimum mandatory technical requirements across BUs and disciplines. The AA GTS 20 also addresses the interface of PAM, with business enablers such as Finance, Supply Chain Management and Leadership People and organization. These interfaces are illustrated in Figure 7.3:

In addition hereto the AA GTS 20 also identifies 14 PAM principles. These principles are illustrated in Figure 7.4 and briefly described in Table 7.5. All AAC, BUs are encouraged to follow these principles to maximize the effectiveness of their respective PAM endeavours.

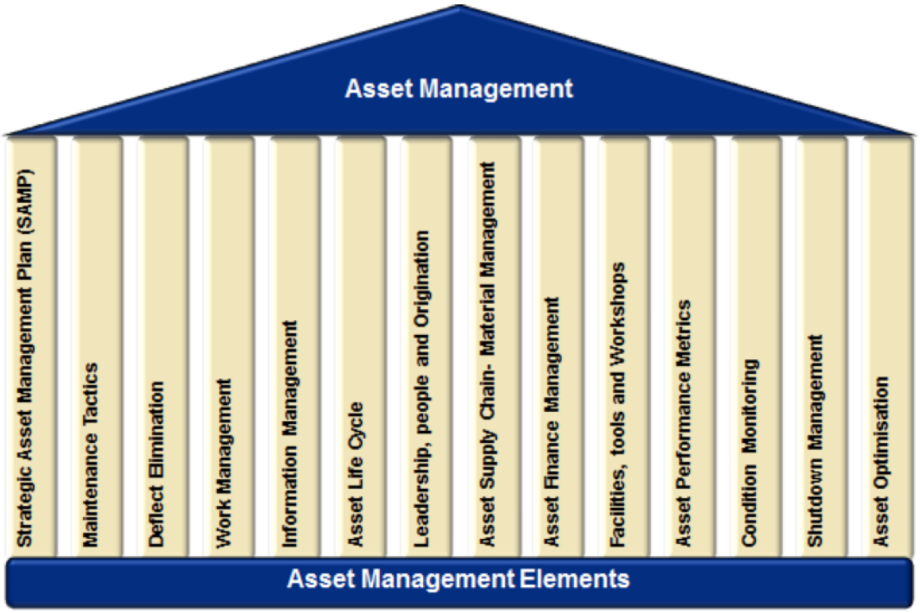
[1]The acronym ASMS as opposed to AMS is used to refer to Asset Management Standard, because the acronym AMS is already used when reference is made to Asset Management Strategy.

Figure 7.3: PAM and business enabler interfaces



Reproduced from AA GTS 20.

Figure 7.4: The AAC PAM principles



Reproduced from AA GTS 20.

Table 7.5: The AAC PAM principles

Principle	Description
Strategic Asset Management Plan:	This principle is focussed on the development of a multiyear improvement plan that is based on a clear vision for AM within the BU. A high level plan that contains the asset management objectives.
Maintenance Tactics:	The focus of this principle is on the development of sound maintenance tactics that aim to prevent the pre–mature breakdown of key equipment thereby providing reliable production at the minimum cost.
Deflect Elimination:	This principle covers the activities required to ensure continuous improvement of engineering AM within the BU
Work Management:	The aim of this principle is to implement and embed sound work and shutdown management practices within the maintenance department to ensure that all asset maintenance related work is carried out in an efficient and cost effective manner. Incorporate Contractor Management
Information Management:	This principle is required to ensure that the computerized maintenance management system is not just used correctly but that it enables the maintenance department to function effectively and efficiently and that it can be used as a tool to drive continuous improvement
Asset Life Cycle:	This principle focusses on ensuring that prior to new equipment being installed or commissioned, due consideration is given to how the new equipment or plant will be maintained in an efficient and cost effective manner and to ensure that all required data and information is captured and stored within the CMMS system prior to commissioning.
Leadership, People and Organization:	This principle is focussed on the human element of asset management and is to ensure that the right people with the right skills are employed and that the workforce is continuously trained not only in technical skills but also all other skills required for effective asset management.
Asset Supply Chain:	This principle is focussed on ensuring that the correct spares and material is available at the time that it is required for the specific maintenance tasks, but that it is done in the most cost effective and efficient manner.
Asset Finance Management:	This principle focussed on the proper management of all equipment related costs over the life cycle of the equipment to ensure that the most effective maintenance is done on the equipment.

Principle	Description
Facilities, Tools and Workshops:	The aim of this principle is to implement and maintain good housekeeping practices within the maintenance workshops and workplaces.
Asset Performance Metrics:	Manage the performance of assets. Benchmark with other equipment and operations and initiate defect elimination, including recognize excellence.
Condition Monitoring:	Monitoring the performance of assets and react when not operating within set design parameters.
Shutdown Management:	Apply work management principle to co-ordinate and ensure effect and efficient shutdowns. Incorporate Contractor Management.
Asset Optimization:	To optimize assets and initiate improvement process.

Reproduced from AA GTS 20.

7.3.3 Assessment of the ABC concentrator PAM landscape

With a mandate to assess the PAM functions and processes within the ABC concentrator a decision was made to utilize triangulation of theory and methodology to increase the reliability of observations.

The Interpretive Paradigm (IP) was selected as the dominant theoretical framework for this assessment. Rubin & Rubin (2011) contends that the IP requires the investigator to examine meanings that have been socially constructed. The IP recognizes that meaning emerges through interaction and is not standardized from place to place and person to person. The IP emphasizes the importance of understanding the overall text of a conversation and, more broadly, the importance of seeing meaning in context.

It is consequently accepted that values and views differ from place to place and group to group. This framework postulates that there is not one reality out there to be measured, objects and events are understood by different people differently, and those perceptions are the reality –or realities- that the researcher focuses on:

"Interpretive researchers try to elicit interviewees views of their worlds, their work, and the events they have experienced or observed. To reconstruct and understand the interviewees experiences and interpretations, interpretive researchers seek thick and rich descriptions of the cultural and topical arenas they are studying and try to develop an empathetic understanding of the world of others"

Rubin & Rubin (2011)

Within the context of the Interpretative Paradigm the project team made used the motivational interview technique. Motivational interviewing focuses on exploring and resolving ambivalence and centres on motivational processes within the individual that facilitate change. The method differs from more "coercive" or externally–driven methods for motivating change as it does not impose change, but rather supports change in a manner congruent with the person's own values and concerns. Motivational interviewing is thus a collaborative, person–centered form of guiding to elicit and strengthen motivation for change. Although the technique requires a non–directional and non–judgemental approach, themes around victories, communication, the optimistic future, support requirements,capacity and expansion were specifically explored.

In summary, according to the interpretative paradigm:

- Reality can be understood and interpreted but not predicted and controlled;
- Knowledge arises from observation and interpretation; and
- Data is collected and analyzed through observation and interviewing.

In addition to information gathered during interviews with key stakeholders the source material evaluated by the project team included but were not limited to the following:

- Plant layout and diagrams;
- Organizational structure;
- Strategy documents to gain a better understanding of the current vision and mission;
- Month end reports;
- A variety of Standard Operating Procedures (SOP's);
- Examples of Job Cards and compliance documentation;

During the preparation phase of this assessment a significant amount of effort was put into ensuring leadership and stakeholder support, before the commencement of the actual information gathering process. Stakeholder analysis was done in conjunction with the organizational leadership.

In line with the principles of triangulation the project team was required to not only rely on information gathered during interviews and document evaluations but to physically observe engineering and operational practices and processes. The observations were made during all shifts including over weekends.

Inductive reasoning was followed in the qualitative analysis of the collected data. Attempts were made to discover key issues, recurrent issues, patterns and relationships

through close scrutiny of the data. Data was analyzed and interpreted by means of inductive abstraction and generalisation. The Constant Comparative method of was used. Units of information were identified during the interviews, which served as the basis for defining categories. Thereafter, units applicable to each category were compared. Two kinds of categories develop in this way: those constructed by the researchers and those that emerged as categories by the respondents through their language and cultural covering terms. The process of Constant Comparison stimulates thought that leads to both descriptive and explanatory categories. The properties of each category are noted by careful scrutiny of all the notes made during the interviews by the research team. The research team then progressed from comparing units with other units classified in the same category, to comparing units with the properties that have been tentatively identified. This was followed by category integration, when relationships between categories become more evident and the category set becomes more coherent. At this point, a specific construction of the phenomenon begins to assume and the construction become delimited. As delimiting occurred, the original list of categories become reducible because of the improved articulation and integration. At the same time, categories become saturated and so well defined, that all further information was found to support the category.

As indicated in Table 7.2 the research team compiled subsequent to the assessment but prior to the operationalization of the the PAMSEEM, a report containing their most critical observations and recommendations regarding existing PAM practices and processes and burning platforms. This PAM Assessment Report (PAR) provided important insight and was frequently referred back to by stakeholders during the PAMSEEM operationalization process. An abridged version of the most critical observations are presented in the next section. The unabridged observations of this assessment as well as the recommendations that were made as are included in Appendix A.

7.3.4 The ABC concentrator PAM landscape: critical observations

In order assist the reader of this text to gain an in-depth understanding of the PAMSEEM validation context the most critical observations made regarding the PAM strategy, policies and practices within the ABC concentrator is presented in this section. During the presentation of these observations, some of the contributions made by stakeholders will be quoted verbatim to substantiate the observations and conclusions made. As indicated all names referred to in this report are however pseudonyms. For ease of reference the pseudo names but **actual** positions of key stakeholders are presented in Table: 7.6.

Table 7.6: The pseudo names and positions of key ABC concentrator stakeholders

Name	**Position**	**Responsibility**
John Peters	PAM Specialist: Corporate Head Office	PAM strategy development and benchmarking

Name	Position	Responsibility
Peter Hlare	Concentrator manager	Executive responsibility for all ABC concentrator activities
Thabo Lerabo	Engineering manager	Operational PAM strategy formulation and execution.
Doep du Plessis	Plant manager	Plant strategy formulation and execution
!Nxu Ngeni	Section Engineer (Wet section)	Optimal availability of Wet section of the plant
John McDonald	Section Engineer (Dry section)	Optimal availability of Dry section of the plant
Sue de Preez	Senior Planner	Maintenance planning and strategy formulation
Spark van Zyl	Electrical foreman (Wet section)	First line supervision of the electrical workshop
Siyabe Mabule	Boilermaker foreman (Wet section)	First line supervision of the boilermaking workshop
Johnson Themba	Plant Night Shift Supervisor (Wet section)	Supervision of all night shift operations
Peter Bulela	Plant Night Supervisor (Dry section)	Supervision of all night shift operations
Pine Pienaar	Fitter	General maintenance
Syia Ngapi	Fitter	General maintenance
Mason Lube	Electrical artisan (Wet section)	Electrical maintenance of the Wet section of the plant
Sunnyboy Mlangu	Electrical foreman (Dry section)	First line supervision of the electrical workshop
Loverboy Johnson	Boilermaker forman (Dry section)	First line supervision of the boilermaking workshop
Gift Mblumbu	Plant Operator (Wet section)	Plant operational tasks

7.3.4.1 Asset management strategy

Observations regarding the nature and quality of the ABC Concentrator PAMS is presented in Section A.7.1 of the PAM Assessment Report (PAR). A number of generic AAP strategy guidelines and documents were found and evaluated. No evidence of a clearly defined and ABC concentrator specific PAM strategy could however be found. Stakeholders acknowledged this shortcoming and indicated that pressure was indeed exerted on them by corporate executives within AAP to develop a ABC concentrator specific PAM strategy. This is confirmed by the following quote:

> *"...the pressure to develop a PAM strategy comes right from the top and every time John Peters, [the consultant][1], talks to me he wants to know how far we are with the strategy..."*

[1]Within the context of the AAP Corporations a number of corporate executives are appointed in specialist roles and are commonly referred to as "consultants" by stakeholders at the various operations.

Thabo Lerabo: Engineering manager

These stakeholders however expressed frustration with the complex nature of existing corporate PAM strategy documentation and guidelines.

> *"...I understand how important the a PAMS strategy is, but I think they [corporate executives] make it far too complex...they sit in their ivory towers and force things down on us..."*

Peter Hlare: Concentrator manager

> *"...look at this diagram it is impossible to explain this to a boilermaker..."*

Sue du Preez: Senior planner

These sentiments were cross referenced and confirmed during interviews with all levels of stakeholders.

7.3.4.2 Organization design

Observations regarding the nature and quality of the Organizational Design is presented in Section A.4.2 as well as Section A.7.9.2. The existing organizational design clearly does not optimally support the creation of a responsive and adaptable PAM function. The PAM department is centralized and no cross-functional or self-managed teams are currently in place. Teams are organized along functional lines, and strong strong evidence of a "us and them" culture and conflict was found.

> *"...if someone from production sees a problem that he/she believes is electrical and fills a job card for the electrical foreman and the electrical artisan finds that the problem is actually for another department, the job gets left without any follow up..."*

Spark van Zyl: Electrical foreman

These observations have been cross referenced and is elaborated in on Sections A.7.4 and A.7.6 of the PAR and referred to in Sections 7.3.4.3, 7.3.4.4 and 7.3.4.6. The design thus does not foster a sense of joint ownership. This is not unique to the ABC concentrator and this phenomenon is found in most organizations were service departments function on a centralized basis.

Senior managers are often straddled between strategic and operational responsibilities and in those instances were managers were forced to get involved in operational issues they were normally unable to provide strategic direction.

"...the Section engineers are very young and inexperienced and I often get bogged down with operational issues...the Fast Track[1] *programme really does not help..."*

Thabo Lerabo: Engineering manager

7.3.4.3 Staff Engagement

In Section A.7.3 of the PAR observations regarding levels of staff engagement are made. Stakeholders especially at lower levels within the organization seemed to be generally disengaged and short term focused. Various stakeholders raised concerns regarding a lack of work ethic and engagement. It was observed that his could be the result of:

- The recent labour unrest in the area:

  "...the things that happened on the Koppie[2] *is affecting as badly ... the people don't trust management..."*

  Mason Lube: Electical artisan

- The eminent change of ownership of the ABC concentrator:

  "...the guys are no longer proud of their work, we don't know for how long we will still be around..."

  Sunnyboy Mlangu: Foreman electrical

- The lack of clearly defined ABC specific strategic objectives:

  "...Thabo has been in that position for 6 months now, he has not spoken to me once ... I do not understand what his plans are..."

  Loverboy Johnson: Forman boiler making

These aspects were not evaluated in detail during the assessment but were highlighted and referred to during the Phase 2 of the operationalization of the PAMSEEM.

[1] The Fast Track programme is focused on the accelerated development and promotion of high potential individuals from previously disadvantaged communities. The programme is controversial and both black and white stakeholders have expressed their frustrations with the programme and its results.

[2] At the Marikana platinum mine, operated by Lonmin at Nkaneng near Rustenburg, 3,000 workers walked off the job on 10 August 2012 after Lonmin failed to meet with workers, to discuss their demands for a minimum wage of R12 500. Between 12 and 14 August, approximately nine people were killed in the area around Marikana. There are conflicting reports on who killed whom during these dates. However, at least four miners, two police officers, and two security guards seem to have been killed during this time. On the afternoon of 16 August 2012, members of a contingent of the South African Police Service, from an elite special unit, opened fire with submachine guns (R5 rifles), on a group of striking miners. Within minutes 34 miners were killed, and at least 78 were wounded. The incident was the single most lethal use of force by South African security forces against civilians since the Sharpeville massacre during the apartheid era (Alexander (2013)).

7.3.4.4 Communication

During the assessment of the characteristics and effectiveness of the communication process, the existing communication methods and communication media, as well as the content of communication efforts were evaluated. The most pertinent observations regarding communication is presented in Table A.1 and is reproduced in Table 7.7 for ease of reference.

From the presentation it should be clear that there is very little focus on any strategic content during formal communication. During in-depth interviews with a number of key stakeholders this observation was cross referenced and confirmed.

> *"...there is a lot of crises management around here... we do not often get the chance to sit back and plan for the future..."*
>
> !Nxu Ngeni: Section Engineer

> *"...I suppose he (Thabo Lerabo) is still finding his feet but he has never shared his strategy or vision with me... they only fight fires..."*
>
> John McDonald: Section Engineer

In line with the observations regarding communication the managerial style in general seem to be top-down and non-participative.

Table 7.7: ABC concentrator communication characteristics

Communication method	**Purpose and typical content**	**Level of participation**
Daily workshop meeting	Feedback regarding the maintenance jobs that were completed the previous day and planning regarding jobs that are planned for the day ahead.	Mostly top-down.
Daily joint planning meeting	Representatives from both the Engineering and the Operations departments are present during this meeting. The purpose is to identify critical maintenance problems, but more importantly to plan for preventative maintenance operations. This meeting is often characterized by conflict and blame-shifting, and the focus is generally re-active.	Despite the fact that the meeting is on any day attended by no less than 10 – 15 representatives, very few stakeholders actively participate.
Monthly engineering meeeting	The purpose of this meeting is to provide feedback to the engineering team on organizational performance and projects planned for the month ahead.	This is a typical "town hall" style meeting with very little to not participation from attendees.

Communication method	Purpose and typical content	Level of participation
Notice boards	The purpose of notice board communication is unclear and most communication on notice boards are extremely dated and mostly irrelevant.	
E-mail	E-mails are mostly used to share operational information and to provide feedback on progress.	Only staff from foreman level upwards have access to E-mail communication.

7.3.4.5 Human Capital Readiness

There seem to be a lack of technical as well as leadership skills especially at the first line and foreman level. This is confirmed by observations made in Section A.7.2 of the PAR on the effectiveness of the "Fast Track programme" and referred to in Section 7.3.4.2 as well as observations made in Section A.7.5 of the PAR and confirmed by the following quote:

> *"... the artisans were promoted to the foremen position too prematurely... there are skills in the market but they (management) arent tapping into them. They have developed training matrices for artisans and foremen, however it will take a while to take effect..."*
>
> Siyabe Mabule: Boilermaker foreman

This state of affairs might have been the result of a multiplicity of factors. A detailed analysis of the factors fell outside the scope of the initial assessment.

7.3.4.6 Inter-departmental relations

The quality of Inter-departmental relations has already been alluded to in Section 7.3.4.4 when reference was made to the fact the daily Joint Planning Meeting (attended by both Engineering and Plant staff) were characterized by conflict and blame-shifting. The underlying conflict between Engineering departments and Operations departments is not unique to the ABC concentrator, the predecessors to both Thabo Lerabo and Piet du Plessis, apparently had a particularly adversarial relationship. The conflict between these two senior managers permeated through to their respective team members. Since the appointment of Peter Hlare in October 2013 and the subsequent appointment of Piet du Plessis in November 2013 and Thabo Lerabo in January 2014 a lot of effort was put into breaking down the silos that existed between Engineering and Plant staff.

At the operational level strong evidence of a "us and them" culture was however still found. These observations were described in Section A.7.4 as well as Section A.7.6 of the

PAM Assessment Report. The following quotes are included to illustrate the level and extent of Inter-departmental relationship problems at the ABC concentrator at the time of the PAM assessment.

Plant supervisors and operators expressed huge frustration with the quality and level of service they received from the Engineering department.

> *"...these guys have no pride...they fix the same thing over and over..."*
>
> Gift Mblumbu: Plant Operator (Wet section)

The problem seem to be exacerbated during back shifts and over weekends when no engineering staff are at the plant.

> *"...we need to first go through all the channels to get a call-out approved only to be told by the electrician (when he eventually arrives) that he can only fix the problem if a Fitter assists him...by then we have lost the production for the total shift..."*
>
> Johnson Themba: Plant Night Shift Supervisor

> *"...in the past they used to have "charge hands" ...these guys were able to fix everything – especially during night shift...*
>
> Peter Bulela: Plant Night Supervisor

Engineering supervisors and operators however also expressed frustration. Especially at the fact the Plant supervisors and operators seem to take no ownership of the maintenance of equipment.

> *"...these guys have been working here for many years, they can hear a when a pump is makes funny noises... why do they wait until it breaks?"*
>
> Pine Pienaar: Fitter

> *"...they walk past this conveyer belt three of four time a day ... did they not see the tear?...these guys really don't care...it far easier just to wait until it breaks..."*
>
> Syia Ngapi: Fitter

The daily Joint Planning Meeting (referred to in Table A.1) was an initiated by Thabo Lerabo and Piet du Plessis to address some of these relationship issues. These meetings are however also characterized by conflict and the leadership team should investigate more ways to improve inter-departmental working relations.

7.3.4.7 Defect Elimination (DE)

DE as a method of defect identification and elimination has been well documented in PAM literature and referred to in Section 4.3.5.3. DE offers a systematic approach in which the root cause of a problem or failure is identified, and following a "bottom up" approach, a solution to the problem can be found.

In Section A.7.7 a number of areas that would greatly benefit from the application of DE principles and practices were however identified. These include the following:

- Water spillages and leaks all over the plant;
- Scrap lying around;
- Non-functional cooling systems in the control and instrumentation rooms;
- Replacement of rubber cylinders
- Overflowing pebble boxes and water drainage

Most stakeholders (including the Engineering manager as well as the Section Engineers) indicated that they understood the importance and value of DE. They also often referred to the fact that John Peters (the PAM Specialist: Corporate Head Office) is a big DE advocate. Despite all the knowledge about DE as well as the pressure applied by Corporate Head Office to implement DE principles and practices no evidence of any DE strategy or action plan was found during the PAM assessment. The research team highlighted this observation as a classical example of Physical Asset Management Strategy Execution Failure.

7.3.4.8 Condition Monitoring (CM)

Observations regarding the nature and extent of CM within the context of the ABC concentrator were made in Section A.7.8 of the PAR.

As in the case with DE most key stakeholders indicated that they understood and accepted the value of applying the principles and practices of CM. Although no CM strategy or policy document is in place within the ABC concentrator context strong evidence of CM on most critical assets were found. CM is done both in–house and through outsourced partners. CM is furthermore done both on-line through the SCADA system and offline using various instruments such as infra red cameras, infra red thermometers, accelerometers and oil samples.

The ad hoc approach the organization has towards CM and the absence of a clearly defined CM strategy (despite the obvious advantages) was also highlighted by the research team as an example of PAMSEF within the context of the ABC concentrator.

7.3.4.9 Work Management (WM)

The design and implementation of a WM system is an essential element to the efficient utilization of resources and systems in the management of maintenance activities. It is a key component of the control mechanisms portfolio available to maintenance management.

The following specific observations regarding WM have been made in Section ass:wm of the PAR:

- **Documentation** – The documentation process that needs to be followed before any job/task can be done on the plant is tedious and time-consuming;
- **Follow through and feedback** – There seem to be very limited follow through and feedback after the completion of tasks. Artisans are often both executor and inspector. In addition hereto problem identifiers seldom if ever receive feedback when problems are solved;
- **Communication** – Ineffective communication has already been referred to in Section A.7.4 of the PAR and in Section 7.3.4.4 above. It has been observed that there is a serious gap in communication between Engineering and Production that often results in blame shifting;
- **Planning** – The overall contention is that planning is ineffective. This reality has a significant impact on the total PAM function and should be addressed as a matter of urgency;
- **Call–out management and overtime** – Stakeholders were concerned that the management of call-outs and overtime is not effective. Some of these aspects were already referred in Section A.7.6 of the PAR and Section 7.3.4.6 above. The ineffectiveness of this process was cross referenced and observed during a number of back-shifts.

7.3.4.10 Asset financial management

A number of observations regarding PA financial management at the ABC concentrator are presented in Section A.7.10 of the PAR These include the following:

- **Granularity of budgets and cost reports** – The lowest common denominator on all cost reports are currently Cost Centres. This is the result of way in which SAP has been configured. This set-up makes it virtually impossible to hold foremen accountable for cost control since the responsibilities of Foremen often overlap numerous sections or are limited to only parts of a particular section;

- **Asset categorization** – No evidence could be found of any asset categorization table or methodology. The implication is that decision makers are struggling to decide which assets and spares are more or less critical; and
- **Cost-benefit analysis** – No evidence of a clearly defined protocol regarding costs-benefit analysis could be found. Stakeholders indicated that they often find it difficult get assistance when cost-benefit trades-off need to be made and were these frustrated by slow responses when requests for cost-benefit evaluations are made.
- **Zero value balance sheet assets** - A large number of PAs are acquired through the operational budget. The acquisition of these assets are thus typically regarded as an operational expense (Opex). The implication of this reality is many fold. The first of these are the fact that these assets are not registered on the organizational balance sheet. The non-registration of these assets on the balance sheet however also has severe implication for Asset Life Cycle Management.

Extended financial planning and forecasting cycle times that delay decision making, financial drivers and metrics that don't align with strategies and the ownership of planning projections adds to the frustration of numerous functions.

7.3.4.11 Asset Management Life Cycle (AMLC)

The observation regarding AMLC are presented in Section A.7.11. After numerous formal and informal conversations and interviews with engineering foreman, artisans and planners, it was concluded that no AMLC policy or practices are currently in place within the ACB contentrator context. Not only are the life cycles of assets not managed with any specific policy or long term vision, no staff were aware of the existence of any AMLC principles.

Replace or repair decisions are made with a narrow-minded view on cost saving. Evidence was found of assets performing well below their rated performance level, that were kept in operation to postpone any future capital outlay. The long term cost of asset inefficiency is seemingly not really a consideration.

7.3.4.12 Shutdown management

One of the most resource intensive activities a company can undertake is planning and executing a scheduled plant Shutdown. A Shutdown is done to complete maintenance work that is difficult or impossible to perform while plant equipment is operational. Every industrial plant encounters several Shutdowns during its lifetime, be it for scheduled maintenance, replacement of parts, modification or expansion. The overriding challenge is to adhere to the most stringent safety standards and keep downtime to a minimum.

To achieve that goal, the whole of logistical processes, which is comprised of the lifting, transport, installation and removal of many components, plays an important and interdependent role.

Observations regarding Shutdown is presented in Section A.7.12 of PAR. ABC concentrator is Shutdown for 48 hours every month to do general maintenance and repairs. None of the participants in this assessment were however able to explain why a monthly or 4 weekly Shutdown period was required. In addition hereto there is seemingly no long–term Shutdown plan and Shutdowns are thus planned on a case by case basis. Participants furthermore expressed concern about the effectiveness of Shutdown management in general. These concerns are validated by the fact that the plant is seldom fully operational within the planned Shutdown period.

7.3.4.13 Conclusion

The purpose of this section was to assist the reader to gain a conceptual understanding of the PAM context within which the PAMSEEM was validated. The detail of these observations are presented Appendix A. In the next section the PAMSEEM operationalization within this context will be described in detail.

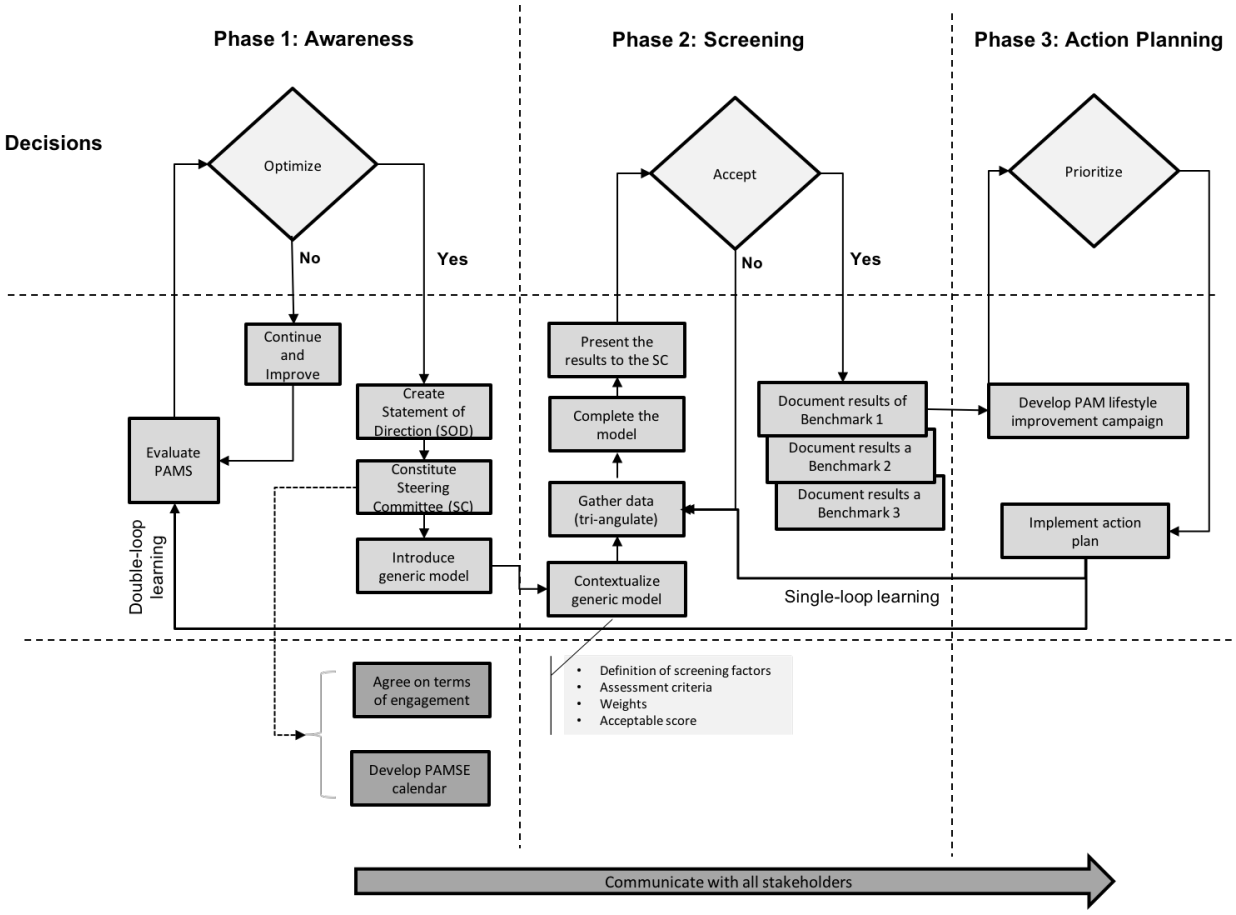
7.4 The PAMSEEM operationalization

In Section 6.2 it was noted that the PAMSEEM is not only a theoretical model to be used within the confines of a laboratory but a practical mechanism that should ultimately become part of the PAM organization's standard operations procedures and DNA. For this reason detailed recommendations were made regarding the practical operationalization of the model. In order to assist the PAM practitioner during the implementation of the PAMSEEM an operationalization framework was presented in Figure 6.4 and is reproduced in Figure 7.5 for ease of reference.

As indicated does the PAMSEEM essentially consist of four phases. The implementation of each one of these phases has value in its own right, and for this reason it was decided to promote these phases in the document hierarchy and to not only discuss them as subsections within the discussion on PAMSEEM operationalization. In the next sections the operationalization and value contributions of each one of the PAMSEEM phases will also be discussed separately . In every discussion the following aspects will be addressed:

1. A description of the operationalization of the relevant phase and the use of prescribed artefacts; and
2. A discussion on the impact and effectiveness, the phase and the use of prescribed artefacts, had on the achievement of the study objectives.

Figure 7.5: The operationilization of the PAMSEEM



In the next section the operationalization and validation of the Awareness phase is presented.

7.5 Creating Awareness

In Section 6.3.3 the most important decision and implementation steps involved in the implementation of Phase 1 of the PAMSEEM were explained. In the next section the operationalization of Phase 1 within the context of ABC concentrator is explained in detail.

7.5.1 Operationalization and use of artefacts

In line with the findings made during the PAM assessment and briefly presented in Section 7.3.4, the ABC concentrator has been under pressure to improve its PAM performance levels for a number of years. The decision to initiate a risk identification and optimization process was thus already taken by senior executives within the organization before the intervention was embarked upon. The "Catalyst for Change" in this instance was thus sub-optimal PAM performance and pressure from the central AAP structures (see Section A.2 and Section A.7.1 of the PAR).

The PAMSEEM recommends the completion of a number of action steps during Phase 1. The operationalization of each of these steps within the ABC concentrator context is described below.

7.5.1.1 Step 1 – Constitute a steering committee:

After consultation with the Concentrator manager, the Engineering manager and the Plant manager, a steering committee was constituted. The composition of the steering committee is presented in Table 7.8.

Table 7.8: Composition of the ABC concentrator PAMSEEM steering committee

Position	Management level	Total
Concentrator manager	Senior Management	1
Plant manager	Senior Management	1
Engineering manager	Senior Management	1
Section engineer (Dry section)	Middle Management	1
Section engineer (Wet section)	Middle Management	1

Position	Management level	Total
Engineering foreman from: • The boiler making workshop; • The electical workshop; and • The planning office;	First Line Management	3
Artisans representing all trades and workshops	Non-management	4
Shift Leaders representing all shifts	First Line Management	3
Operators representing all trades	Non-management	4
Human Resources practitioner	Middle Management	1
	Total	**20**

During the composition of the steering committee great care was taken to ensure representation across functions and management levels.

7.5.1.2 Step 2 – Evaluate PAMS

In the light of the fact that a complete PAM assessment took place prior to the operationalization of the PAMSEEM the evaluation of the PAMS was not a requirement at ABC concentrator. Regular reference was however made to the observations noted in the PAM assessment report.

7.5.1.3 Step 3 – Create a Statement of Direction (SoD)

Based on the observations made during the PAM assessment the steering committee formulated the following SoD:

> *"The ABC concentrator accepts the reality that a number of factors prevent us from achieving our goals. We realize that far more value can be unlocked from our Physical Assets if our Physical Asset Management Strategy is well defined and executed. We are committed to identify these factors pro-actively, understand their impact on the organization and on each other and are prepared to develop action plans to eradicate these factors or to minimize the possible effect they might have during the PAMSE process."*

7.5.1.4 Step 4 – Introduction of the generic PAMSEEM

During a one-day workshop the PAMSEEM principles and objectives were explained in detail to the steering committee. All aspects and requirements were presented and contextualized.

7.5.1.5 Step 5 – Agreement on the terms of engagement

The terms of engagement the steering committee formulated is presented in Table 7.9.

Table 7.9: ABC concentrator PAMSEEM terms of engagement

Mandate of the steering committee

- The steering committee will have access to all information required to complete the screening phases. During the screening process the steering committee may nominate representatives to gather information on their behalf. In the event that any dispute arise regarding the sensitivity of any information, the matter will be referred back to the steering committee who will have the mandate to authorize access to information.
- The screening team will have access to all relevant staff members and can set up meetings with relevant staff members as and when required during the screening period (see PAMSEEM calender).

Meeting intervals

- The steering committee will meet on a weekly basis during the screening period. Thereafter the steering committee will meet as and when reports are presented or when decisions regarding progress or significant process changes need to be taken.

Delegation of authority

- The steering committee can delegate authority to relevant staff members or contractors to assist it during the course of the PAMSEEM operationalization.

7.5.1.6 Step 6 – Develop the PAMSEEM calendar

After agreement regarding the research manadate and scope were reached a research project plans was developed. An abridged version of the agreed project plan (including the PAMSEEM operationalization time table was presented in Table 7.2. The detailed PAMSEEM operationalization calendar as developed by the steering committee is presented in Table 7.10.

Table 7.10: ABC concentrator PAMSEEM operationalization calendar

Project Phase	Duration	Deadline
Phase 1: Awareness		
Step 1 – Constitute steering committee	1 Day	22 September 2014
Step 2 – Evaluate PAMS	See Section 7.3.4	
Step 3 – Create SoD	1 Day	22 September 2014

Project Phase	Duration	Deadline
Step 4 – Introduce generic PAMSEEM	1 Day	23 September 2014
Step 5 – Develop PAMSE calender	1 Day	24 September 2014
Step 6 – Develop stakeholder communication campaing	1 Week	26 September 2014
Phase 2: Screening and detection		
Step 1 – Contextualize the generic screening model	1 Week	3 October 2014
Step 2 – Gather data	2 Weeks	17 October 2014
Step 3 – Complete the model and calculate scores	2 Days	17 October 2014
Step 4 – Interpret the results	1 Week	24 October 2014
Step 5 – Present the results	1 Day	24 October 2014
Phase 3: Action planning		
Step 1 – Develop action plans	2 Weeks	7 November 2014
Step 2 – Prioritize action plans	1 Week	14 November 2014
Step 2 – Implement action plans		According to plan
Phase 4: Learning and feedback		
Step 1 – Data acquisition	Ongoing	Ongoing
Step 2 – Data analysis	Ongoing	Ongoing
Step 3 – Trade-off recommendations	Ongoing	Ongoing

7.5.1.7 Step 7 – Develop the stakeholder communication campaign

In line with the recommendations made in Section 6.3.3 the steering committee considered the principles of internal marketing during the development of the campaign. The committee thus did not only consider the themes they wanted to communicate they also considered the stakeholder groups or market segments as well as the use of the most appropriate communication media. The communication campaign developed by the steering committee is presented in Table 7.11.

Table 7.11: ABC concentrator PAMSEEM communication campaign

Stakeholder group	Communication Media	Timing
Communication Theme 1: Awareness		
Message: Explain the purpose of the intervention as well as the potential impact PAMSEF has on the sustainability of the concentrator.		

Stakeholder group	Communication Media	Timing
Management	• E-mail; • Workshops	• 30 Sep 2014 • 30 Sep 2014–3 Oct 2014
Non-management (English first or second language)	• Posters and bill-boards; • Introduction Workshop; • Morning meetings.	• 30 Sep 2014–14 Nov 2014 • 30 Sep 2014–3 Oct 2014 • 30 Sep 2014–3 Oct 2014
Non-management (English third language) The message as well as communication style will be similar to English speaking non-management. All content however need to be translated into the relative native language.	• Posters and bill-boards; • Introduction Workshop ; • Morning meetings.	• 30 Sep 2014–14 Nov 2014 • 30 Sep 2014–3 Oct 2014 • 30 Sep 2014–3 Oct 2014
Communication Theme 2: Screening and detection		
Message: Introduce and contextualize the factors contributing to PAMSEF[1] and explain the screening an detection process. Emphasize the importance of open and honest feedback during the screening phase. Report on the most important findings of the screening and detection process.		
Management	• E-mail; • Introduction workshops; • Management meetings; • In-depth interviews; • Feedback workshops.	• 3 Oct 2014 • 6–8 Oct 2014 • 6–10 Oct 2014 • 6–17 Oct 2014 • 24–31 Oct 2014
Non-management (English first or second language)	• Posters and bill-boards; • Introduction workshops; • Morning meetings; • In-depth interviews; • Feedback workshops	• 30 Sep 2014–14 Nov 2014 • 6–8 Oct 2014 • 6–10 Oct 2014 • 6–17 Oct 2014 • 24–31 Oct 2014

[1]Specific reference was thus made to the Deadly Dectet (DD) of PAMSEF. The DD illustration as depicted in Figure 6.8, was specifically utitlized as an communication aid during this phase.

Stakeholder group	Communication Media	Timing
Non-management (English third language) The message as well as communication style will be similar to English speaking non-management. All content however need to be translated into the relative native language.	• Posters and bill-boards; • Introduction workshops; • Morning meetings; • In-depth interviews; • Feedback workshops	• 30 Sep 2014–14 Nov 2014 • 6–8 Oct 2014 • 6–10 Oct 2014 • 6–17 Oct 2014 • 24–31 Oct 2014

Communication Theme 3: Action planning

Message: Explain the content as well as potential impact of agreed action plans to all stakeholders.

In the absence of a detailed understanding of the content of action plans it was not feasible to develop a detailed communication campaign for this phase during Phase 1, of the PAMSEEM operationalization.

Communication Theme 4: Learning and feedback

Message: Explain the importance of continuous learning and information sharing. Explain the willingness of the organization to challenge generally accepted assumptions, strategies and work practices.

In the absence of a detailed understanding of the content of the outcome of the screening and detection phase as well as the content of action plans it was not feasible to develop a detailed communication campaign during as part of Phase 1 of the PAMSEEM operationalization.

7.5.2 Impact and effectiveness of the process and artefacts

Awareness in itself plays a critical role in prevention. This has been confirmed in many studies including those done by Mosca *et al.* (2000), and referred to in Section 6.3.1.

In Section 7.2.2 it was however noted that the evaluation of the impact and effectiveness of the operationalization of the Awareness phase within the context of the ABC concentrator would be particularly difficult and complicated by the fact that it was not possible to establish an experimental control environment prior to the operationalization and that a yard stick for the measurement of organizational awareness of PAMSEF casual factors did not exist prior to the study. The implication of these factors are thus that it is impossible to quantify the impact the operationalization of the PAMSEEM had on increased PAMSEF causal factor awareness levels.

During conversations with 15 out the the 20 steering committee members as well as in e-mail correspondence (see Appendix C) that was entered into after the completion of the study it was however confirmed that awareness levels regarding the potential impact PAMSEF could have on the sustainability of the concentrator increased significantly as a result of both the PAM assessment and the PAMSEEM operationalization.

The first expected outcome of the validation process (see Section 7.2.2 was that the operationalization of the PAMSEEM will contribute to organizational awareness regarding factors that lead to PAMSEF. In the light of the above discussion it can thus be concluded that this outcome was achieved.

7.6 Screening and detection

In Section 6.4.3 the most important decision and implementation steps involved in the implementation of Phase 2 of the PAMSEEM were explained. In the next sections the operationalization of Phase 2 as well as the impact and effectiveness of this phase within the context of ABC concentrator is explained in detail.

7.6.1 Operationalization and use of artefacts

The implementation steps as well as the artefacts used during operationalization of Phase 2 of the PAMSEEM is discussed in more detail in this section.

7.6.1.1 Step 1 – Contextualization of the screening scorecard

The generic screening scorecard as illustrated in Figure 6.9 was introduced to the steering committee. After deliberation and with full cognisance of the observations made during the PAM assessment the composition of the screening scorecard was finalized. The DDFs were weighted and the Total Possible Contribution (TPC) of each factor calculated. In line with the recommendations made in Section 6.4.2.2 it was agreed to utlize multivariate assessment criteria as part of this scorecard and the steering committee decided to use the following three Multivariate Assessment Topography (MAT) dimensions:

1. In place – mainly referring to the availability and quality of strategies, policies, procedures and action plans;
2. Maturity – mainly referring to organizational awareness and understanding of available strategies, policies, procedures and action plans; and
3. Performance – mainly referring to the perceptions of key stakeholders regarding the extent to which goals and objectives are achieved.

In addition hereto it was agreed to use a a five level Likert scale during the evaluation of various PAMSEF casual factors. It was agreed that the five levels should have the following descriptions:

1. Strongly disagree;
2. Disagree;
3. Neither agree nor disagree;
4. Agree;
5. Strongly agree.

The uncompleted ABC concentrator screening scorecard is presented in Table 7.12[1].

Table 7.12: ABC concentrator PAMSEEM screening scorecard

Deadly Dectet Factor	**FW**	**TPC**	**IPS**	**MAS**	**PS**	**TFS**	**TFS %**
Quality of Direction							
Strategy Formulation	20%	3.00					
Executors of Strategy	10%	1.50					
Quality of Design							
Organizational Design	15%	2.25					
Interdepartmental Relations	5%	0.75					
Management Control Systems	5%	0.75					
PAM Systems, Processes and Practices	20%	3.00					
Quality of Interpersonal Processes							
Communication	15%	2.25					
Change Management	2,5%	0.37					
Consensus and Priorities	2,5%	0.37					
Commitment	5%	0.75					
Totals	**100%**	**15**					

[1]For ease of reference the acronyms used in the model is described here:

- Factor Weight (FW);
- Total Possible Contribution (TPC);
- In Place Score (IPS);
- Maturity Score (MAS); and
- Performance Score (PS).

.

7.6.1.2 Step 2 – Data gathering

During the PAM assessment phase the research team collected critical information, and as indicated in Section 7.3.4 the team applied the principles of triangulation and was required to not only rely on information gathered during interviews and document evaluations but to physically observe engineering and operational practices and processes. The observations were made during all shifts including over weekends.

Inductive reasoning was followed in the analysis of the collected data. Attempts were made to discover key issues, recurrent issues, patterns and relationships through close scrutiny of the data. Data was analyzed and interpreted by means of inductive abstraction and generalisation.

In Section 7.5.1.1 it was illustrated that the steering committee represented the organization across functions and management levels. At the outset of the data gathering process during Phase 2 of the PAMSEEM operationalization, the steering committee evaluated the PAM Assessment Report (PAR) in detail, but also evaluated the raw data collected during the PAM assessment. In the light of the insight the steering committee gained from the PAR, availability of the raw data gathered during the assessment process as well as the fact that the steering committee had a clear mandate and truly represented the total organization, it was decided not to consult additional staff or management again during the data gathering process.

7.6.1.3 Step 3 – Scorecard completion and score calculation

In the light of all available information the steering committee completed the screening scorecard during a two-day workshop. The workshop was facilitated by the research team and all decisions were taken through consensus. Specific observations and facts that were considered and debated by the steering committee prior to reaching final consensus is presented in Table 7.13 .

Table 7.13: Observations and facts considered during the PAMSEEM scorecard completion

Deadly Dectet Factor	**Observations and facts**
	Quality of Direction
Strategy Formulation	In order to evaluate the quality of the existing PAMS the steering committee relied on the observations made in Section A.7.1 of the PAR as well as on the feedback provided by Thabo Lerabo. Based on these inputs the steering committee concluded that despite the fact that the AAP corporate office has a well-defined Physical Asset Management Strategy and policy, no ABC concentrator PAMS is in place, and for this reason a very low score was given in all three MAT dimensions.

Deadly Dectet Factor	**Observations and facts**
Executors of Strategy	The observations made in Section A.7.2, Section A.7.3, Section A.7.5 as well as Section A.7.6 of the PAR were considered during the evaluation of the capacity and willingness of key stakeholders to execute the PAMS. Based on the observations that: • Senior managers are often straddles between strategy and operations because lower level staff are not properly trained or does not have sufficient experience (see Section A.7.2); and • Staff members especially at lower levels seem to be generally disengaged and short term focused (see Section A.7.3). The steering committee agree that the "Executors of Strategy" indeed pose a threat to effective execution of the PAMS. Considering the fact that a number of key appointments have recently being made the steering committee however decided to give a relatively high score for the first MAT dimension, a neutral score for the second MAT dimension and a low score for the third.
	Quality of Design
Organization Design	The observations made in Section A.7.2, Section A.7.4 as well as Section A.7.6 were considered during the evaluation of the appropriateness of the OD. In the PAR it was concluded that: • The existing organizational design clearly does not optimally support the creation of a responsive and adaptable PAM function; • The PAM department is centralized and that no cross-functional or self-managed teams are currently in place; and • Teams are organized along functional lines, and that there is strong strong evidence of a us and them culture and conflict. The steering committee concurred with these observations and for this reason a relatively low score was given in all three of the MAT dimensions.

Deadly Dectet Factor	**Observations and facts**
Interdepartmental Relations	The observations made in Section A.7.4 as well as Section A.7.6 were considered during the evaluation of the quality of Interdepartmental Relations. The steering committee took cognisance of the fact that the executive team under the leadership of Peter Hlare has spend a considerable amount of time to break down the silos that existed between Engineering and Plant staff. The steering committee however also noted the observations regarding the "us and them" culture that were still evident at the operational level. The steering committee however concluded that the existing prevalence of sub-optimal Interdepartmental Relations was still mainly a consequence of the adverserial relationship that existed between the predecessors of John Hlare and Piet du Plessis and that relationship were improving. For this reason the committee gave a relatively high score for the first two MAT dimensions in an attempt to acknowledge the effort taken by the existing executive team to improve Interdepartmental Relations and a relatively low score for the third dimension (Peformance) to flag the reality that conflict still exist and that this factor should be monitored on a continuous basis.
Management Control Systems	In addition to the observations made in Section A.7.11 as well as Section A.7.14 of the PAR, regarding the effectiveness of the AMLC and the AM Information System the steering committee considered the following realities during the evaluation of the effectiveness of the existing PAM Management Control System (MCS): • SAP is a very powerful information management tool, but it was not utilized effectively within the organization; • No dedicated PAM scorecard is in place to evaluate actual performance against targeted performance; • No "Plan–Do–Check" cycle is in place at the strategic or operational level; and • The current employee Performance Management process is extremely cumbersome and often described by stakeholders as irrelevant. In the light of these observations and realities the steering committee gave a neutral score for MAT dimension one but low scores for MAT dimensions two and three.

Deadly Dectet Factor	**Observations and facts**
PAM Systems, Processes and Practices	In the PAR the following observations were made regarding PAM Systems, Processes and Practices (PSPP): • Section A.7.7: Defect Elimination (DE); • Section A.7.8: Condition Monitoring (CM); • Section A.7.9: Work Management (WM); • Section A.7.10: Asset Financial Management; • Section A.7.11: Asset Management Life Cycle (AMLC); • Section A.7.12: Shutdown Managment; • Section A.7.13: Asset Supply Chain Management; • Section A.7.14: Asset Information Management; • Section A.7.15: Safety, Health and Environment; • Section A.7.16: Asset Care and Maintenance; • Section A.7.17: Risk Management; • Section A.7.18: Criticality Analysis; • Section A.7.19: Facilities, Tools and Workshops; and • Section A.7.20: Contractor Management. The steering committee considered the observations made in these sections and none of it were disputed[1]. The steering committee however did not consider these observations to gain an in-depth understanding of all existing PAM shortcomings, the aim was to understand the extent to which the PSPP were appropriate, joined-up and aligned to the strategy, in place and in-use. In line with this objective and with a full understanding of the relative immature state of the PAMS the steering committee came to the following conclusion – in those instances were PSPP were in place they seemed to be appropriate, none of these PSPPs were however aligned to any form of strategy and for that reason it was impossible to determine the extent to which asset performance (good or bad) could be related to the deployment of these PSPPs. The steering committee thus gave a neutral score for MAT dimension one and low scores for dimensions two and three.
Quality of Interpersonal Processes	

[1]In the light of their understanding of the PAMSEEM principles the committee also acknowledged that despite the temptation to prioritize the development of action plans to address these aspects, it would be a potentially futile exercise to attempt to address these aspects without also addressing the other factors contributing to PAMSEF.

Deadly Dectet Factor	**Observations and facts**
Communication	The observations made in Section A.7.2, Section A.7.4 as well as Section A.7.6 were considered specifically during the evaluation of the extent to which organizational communication either enable or inhibit the execution of the PAMS. It was concluded that the majority of communication efforts were indeed top-down and included very little or no strategic content. For this reason a relatively low score was given in all three MAT dimensions.
Change Management	Change Management refers not only to the tactics used during the implementation of change efforts but more importantly refers to the extent to which the executives within the organization are driving and sponsoring the change efforts. In the light of the fact that all executives including the ABC concentrator manager are members of the steering committee a very high score was given in all three MAT dimensions.
Consensus and Priorities	Consensus and Priorities refer to the nature and extent to which the organization focus on those issues that matters most, as well as to the extent to which key stakeholders agree on these priorities. After the in-depth analysis of all factors that potentially lead to PAMSEF and described above, the steering committee was able to determine five priorities that were then translated into detailed action plans. These action plans are presented in Section 7.7. Despite that fact that the steering committee was unable to make any judgment calls on the performance of agreed upon priorities, the determination of priorities were not coincidental, but the result of thourouht analysis and debate, the steering committee thus gave relatively high scores for the first two MAT dimensions and a neutral score for the performance dimension.
Commitment	Despite the fact that reference was made in Section A.7.3to the fact that stakeholders especially at lower levels within the organizational ranks seemed to be generally disengaged and short term focused, the steering committee came to the conclusion that a number of the factors that lead to these high levels of disengagement were being addressed or were no longer relevant. For this reason the steering committee gave neutral scores in all three MAT dimensions.

In order to streamline the process an Microsoft Excel spreadsheet was configured to automate the calculations described in Section 6.4.2. The completed ABC concentrator PAMSEEM screening scorecard is presented in Table 7.14.

Table 7.14: ABC concentrator PAMSEEM screening scorecard

Deadly Dectet Factor	FW	TPC	IPS	MAS	PS	TFS	TFS %
Quality of Direction							
Strategy Formulation	20%	3.00	2	2	2	1.2	40%
Executors of Strategy	10%	1.50	4	3	2	0.9	60%
Quality of Design							
Organizational Design	15%	2.25	3	2	2	1.05	46%
Interdepartmental Relations	5%	0.75	4	3	2	0.45	60%
Management Control Systems	5%	0.75	3	2	2	0.35	46%
PAM Systems, Processes and Practices	20%	3.00	3	3	2	1.6	53%
Quality of Interpersonal Processes							
Communication	15%	2.25	3	2	2	1.05	46%
Change Management	2,5%	0.37	4	4	4	0.2	80%
Consensus and Priorities	2,5%	0.37	4	4	4	0.2	80%
Commitment	5%	0.75	3	3	3	0.45	60%
Totals	**100%**	**15**				**7.45**	**49.6%**

7.6.1.4 Step 4 – Interpretation of results

After completion of the scorecard and the calculation of scores the steering committee in conjunction with the research team used the guidelines provided in Table 6.8 to interpret the results and compile the PAMSEEM screening report.

The ABC concentrator PAMSEEM screening report is presented in Table 7.15.

Table 7.15: The ABC concentrator PAMSEEM report

Deadly Dectet Factor	FW	TFS%	Interpretation
Quality of Direction Strategy Formulation	20%	40%	It is strongly recommended that the organization should as a matter of urgency, invest time and resources to ensure the development of a ABC concentrator specific Physical Asset Management Strategy.

Deadly Dectet Factor	FW	TFS%	Interpretation
Executors of Strategy	10%	60%	Senior managers are often straddled between strategic and operational responsibilities because lower level managers are not properly trained or does not have sufficient experience. This is serious problem but considering the resource limitations within the organization and the fact that there are factors that are considered to be more important, the organization should not attempt to address this problem in the next six to twelve months. The DDF should however be closely monitored and if the score does not improve as a result of action plans being implemented in other areas, a dedicated action plan to address the capacity of middle and first line management should be contemplated.
Quality of Design Organizational Design	15%	46%	Organizational Design is an important DDF. The score is very low and immediate action is required. Long term sustainability is not possible within the context of a non-functional organizational structure. It is thus recommended that the underlying factors evaluated during the assessment of the OD should be evaluated in detail and that a detailed improvement plan (that may include Organizational re-design) should be formulated.
Interdepartmental Relations	5%	60%	Despite the relative low weight that Interdepartmental relations carries within this context the score is still relatively low. This score should be read in conjunction with the low score for OD. The steering committee however noted that effort of the executive management team to address the existing relationship dynamics. If the score does not improve as a result of action plans implemented to address OD aspects, a dedicated action plan to address Interdepartmental relations should be considered.
Management Control Systems	5%	46%	The score for this DDF is very low. The development of action plans to improve management control will however be futile if an appropriate PAMS is not formulated. The development of a PAM scorecard as well as the implementation of a Plan–Do–Act feedback cycle should be considered as part of the development of the PAMS. The optimized use of the SAP system should also become an objective in the short to medium term. This factor need to be evaluated again in the next twelve months.

Deadly Dectet Factor	FW	TFS%	Interpretation
PAM Systems, Processes and Practices	20%	53%	The organization should take note of the immature state of PSPPs. In addition to the fact that many PAM Processes and Systems have not been defined, those systems and processes that have been defined are not joined-up and are not aligned to the strategy. A detailed action plan to address this state of affairs need to be developed as a matter of urgency. It is also recommended that this factor is monitored closely and evaluated on a three monthly basis until such time that the score increase.
Quality of Interpersonal Processes			
Communication	15%	46%	Organizational communication is central to most processes including training, knowledge management and learning. The communication score is low and it is strongly recommended that the communication dynamics within the organization is evaluated in more detail. Based on the finding of the in-depth analysis an action plan should be developed to address communication inefficiencies.
Change Management	2.5%	80%	Evidence could be found of some change management tactics and practices currently being employed within the organization. Despite the fact that Change Management carries a relatively low weight the non-acceptance of these tactics as well as the non-performance of these tactics has a significant impact on the performance of a number of other DDFs. For this reason it is recommended that the organization investigates the effectiveness of Change Management tactics in far more detail. Specific cognisance should be taken of the cultural values of all stakeholders to ensure the use of appropriate Change Management tactics.
Consensus and Priorities	2.5%	80%	The PAMSEEM implementation process is consultative in nature and requires stakeholders to engage in continuous dialogue. For this reason there seem to be very high levels of consensus on priorities. The formulation of the PAMS will however also involve the setting of priorities. Against the backdrop of the relatively unhealthy Interdepartmental relationships that currently exist at the operational level it is however strongly recommended that this factor should monitored and evaluated on a three monthly basis.

Deadly Dectet Factor	FW	TFS%	Interpretation
Commitment	5%	60%	It was noted that staff at the operational level seem to be generally disengaged. In the light of the fact that levels of engagement and commitment is a lagging indicator and with full cognisance that a number of action plans will be developed that might have an impact on staff engagement and commitment levels immediate action regarding this DDF is not recommended. It is however strongly recommended that Commitment levels should be monitored and evaluated on a three monthly basis.
Total		**49.6%**	The PAMSEF Score is border-line critical. Although the PAM organization might at this juncture still achieve some results, there are a range of critical factors that need to be addressed to prevent complete PAMSEF and possible disaster in the short and medium term.

7.6.1.5 Step 5 – Presentation of results

After completion of the PAMSEEM screening report it was presented[1] to various stakeholder groups in line with the communication campaign described in Table 7.11. The aim of these feedback sessions were not only to provide feedback but also to extract information from stakeholders that were used during the development of action plans.

Focus group principles were applied to ensure optimal stakeholder participation, and joint problem solving principles as introduced in Section 4.4.2.3 were applied to ensure that solutions for the presented problems were found in the most effective way. These sessions were thus treated as both an important group learning moment and an opportunity to tap into the tacit knowledge base that exist within the organization.

7.6.2 Impact and effectiveness of the process and artefacts

In Section 6.4 it was indicated that screening for PAMSEF has three pre-requisites:

- Thorough understanding of the factors that cause PAMSEF;
- The availability of an instrument that could be used to screen for these factors; and
- A reporting mechanism that PAM practitioners could use to interpret the screening results.

[1]The Microsoft Powerpoint presentation used during these sessions are included in Appendix D.

It was furthermore confirmed in Section 6.4 that after an extensive literature review no model, methodology or instrument could be found to empower and enable PAM practitioners and academics to screen and detect factors causing PAMSEF. A number of Screening artefats thus had to be developed to enable and assist PAM practitioners and academics during the screening process. These artefacts were described in Section 6.4.2 and their operationalization within the context of ABC concentrator had the following impact:

- As in the case with the diagnostic report of a patient, the PAMSEEM screening report highlighted the most critical PAMSEF risk areas;
- It gave the steering committee the opportunity to provide informed and structured feedback to all stakeholders. The quality and scientific nature of the feedback raised that the status and credibility of the both the report and the steering committee;
- The screening and dectection process contributed further to raised PAMSEF awareness levels. This is confirmed by the fact that Physical Asset Management Strategy and its execution is included on the agenda of all executive and operational meetings; and
- In line with the principles of the learning organization (introduced in Section 2.4.1) the steering committee did not only use the feedback sessions to provide feedback on the findings of the screening report, but also used the opportunity to extract recommendations from the stakeholders on ways to address these risks. These inputs were all incorporated during the development of action plans.

The second expected outcome of the validation process (see Section 7.2.2 consisted of two parts:

1. The operationalization of the PAMSEEM will contribute to the early detection and screening of factors causing PAMSEF; and
2. The operationalization of the PAMSEEM will contribute to the management of these factors.

In the light of the above discussion it can thus be concluded that the operationalization of Phase 2 did contributed to the early detection of PAMSEF. In the absence of effective screening, the development of action plans would however also have been a completely unfocused exercise. With the insight gained during the screening and detection phase the steering committee in conjunction with the research team was able to develop and prioritize the following action plans.

7.7 Action Planning

In Section 6.5.3 the most important decision and implementation steps involved in the implementation of Phase 3 of the PAMSEEM were explained. In the next sections the operationalization of Phase 3 as well as the impact and effectiveness of this phase within the context of ABC concentrator is explained in detail.

7.7.1 Operationalization and use of artefacts

The ABC concentrator PAMSEEM screening report was presented in Table 7.15. In line with the recommendations made in the report the steering committee agreed that a number of action plans had to be developed. An abridged version of each one of these action plans are presented in the following section.

7.7.1.1 Step 1 – Develop action plans

The steering committee came to the conclusion that the following five action plans had to be developed as a matter of urgency. The action plan format recommended in Section 6.5.2 was used during the development of these actions plans.

1. Define the Physical Asset Management Strategy (PAMS) and ensure alignment with organizational and corporate goals.

Table 7.16: Action plan 1: Define and align the ABC concentratorPAMS

Objective: Develop an ABC concentrator specific Physical Asset Management Strategy.			
Step	**Description**	**Responsible**	**Deadline**
Step 1	Schedule a three-day strategy planning workshop.	Thabo Lerabo	End of Nov 2014
Step 2	Identify and invite relevant stakeholders and consider the involvement of an external or neutral facilitator	Thabo Lerabo	Mid Nov 2014
Step 3	Facilitate the strategy planning workshop	Thabo Lerabo or designated facilitator	End Nov 2014
Step 4	Document the formulated strategy and communicate with Corporate head office and ensure sign-off	Thabo Lerabo	Mid Dec 2014
Key Project Deliverables			
• Documented strategy; • Strategy signed-off by ABC concentrator executive committee; • Strategy signed-off be Corporate Head Office			
Financial Impact			

Step	**Cost**
Step 1	R25 000
Step 2	No Cost
Step 3	R150 000
Step 4	(see Step 3)
Total	**R175 000**

2. Re-evaluate and benchmark the existing PAM Organizational Design (OD);

Table 7.17: Action plan 2: Optimize the existing PAM Organizational Design

Objective: Optimize the existing PAM Organizational Design			
Step	**Description**	**Responsible**	**Deadline**
Step 1	Benchmark existing structure against best practice in the group as well as across industries	Thabo Lerabo	End of April 2015
Step 2	Present findings of benchmark exercise to the steering committee	Thabo Lerabo	Mid May 2015
Step 3	Agree on basic design principles	Steering committee	End May 2015
Step 4	Finalize conceptual organizational redesign	Thabo Lerabo or designated facilitator	End June 2015
Step 5	Present optimized design to steering committee and ensure sign-off	Thabo Lerabo	Mid July 2015
Step 6	Present optimized design to Corporate Head Office and ensure sign-off	Thabo Lerabo	End July 2015
Step 7	Prepare the organization for change	Thabo Lerabo	End August 2015
Step 8	Implement new design	Thabo Lerabo	End October 2015

Key Project Deliverables

- Benchmark report;
- Well-defined design principles;
- Optimized Organizational Design;
- Successful implementation of optimized OD

Financial Impact

Step	**Cost**
Step 1	R25 000
Step 2	R10 000
Step 3	R50 0000
Step 4	R300 000
Step 5	R10 000
Step 6	R10 000
Step 7	R150 000
Step 8	R150 000
Total	**R705 000**

3. Develop a Failure Defence Plan (FDP) for critical assests.

Table 7.18: Action plan 3: Failure Defence Plan for critical assets

Objective: Develop a Failure Defence Plan for critical assets			
Step	**Description**	**Responsible**	**Deadline**
Step 1	Conduct a criticality analysis	Thabo Lerabo	End of February 2015
Step 2	Complete Failure analysis procedure including the following: • Analysis of all the potential failure modes of the various parts of a system; • Analysis of the effect these failures may have on the system; and • Identification of methods to avoid the failures, and/or to mitigate the effects of the failures on the system.	Thabo Lerabo	End May 2015
Step 3	Select appropriate tactics to defend the organization against future asset failure	Thabo Lerabo	End of June 2015
Step 4	Develop detailed task list	Thabo Lerabo	End of July 2015
Step 5	Asset care plan execution	Thabo Lerabo	Ongoing according to plan

Key Project Deliverables

- Completed criticality analysis;
- Completed failure analysis;
- Selection of appropriate tactics; and
- Completed detailed task list.

Financial Impact

Step	**Cost**
Step 1	R75 000
Step 2	R150 000
Step 3	R150 000
Step 4	R150 000
Total	**R525 000**

4. Develop a PAM communication strategy;

Table 7.19: Action plan 4: Physical Asset Management communication strategy

Objective: To address the in-efficiencies in the current PAM Communication process				
Step no.	**Description**	**Responsible**	**Deadline**	**KPI**
Step 1	Analyze existing communication process in detail	XYZ Consult	August 2015	Completed communication audit

Step no.	Description	Responsible	Deadline	KPI
Step 2	Present findings of audit to the steering committee	XYZ Consult	Sept 2015	
Step 3	Develop Communication campaign to ensure awareness, understanding and acceptance of the PAMS	Steering Committee	Oct 2015	Evaluation of impact of campaign

Financial Impact

Step no.	Cost
Step 1	R250 000
Step 2	R250 000
Step 3	No Cost
Step 4	R250 000
Total	R750 000

5. Develop a PAM Human Asset Register.

Table 7.20: Action plan 5: PAM Human Asset Register

Objective: Develop a Human Asset Register facilitate the development of executors of the PAMS

Step no.	Description	Responsible	Deadline
Step 1	Confirm the existing engineering strategy objectives	Consulting ABC	June 2015
Step 2	Confirm the current engineering processes and workflow	Consulting ABC	June 2015
Step 3	Confirm that the definition and content of current role profiles are relevant	Consulting ABC	June 2015
Step 4	Definition of technical competency library	Consulting ABC	June 2015
Step 5	Definition of behavioural/leadership competency library	Consulting ABC	June 2015
Step 6	Development of technical and behavioural competency matrix	Consulting ABC	June 2015

Key Project Deliverables

- Human Asset Register reflecting both the ideal state as well as the current state; and
- Detailed action plan to close the gap.

Financial Impact

Step no.	Cost
Step 1	See Action Plan 1
Step 2	R25 000
Step 3	R75 000
Step 4	R75 000
Step 5	R75 000
Step 6	R75 000
Total	R325 000

7.7.1.2 Step 2 – Prioritize action plans

Despite the relative importance of each one of these action plans the steering committee was constrained by the non-availability of resources and was unable to implement all these plans at once and thus had to prioritize. The committee initially contemplated to utilize some of the sophisticated prioritization methodologies recommended by Bam & Vlok (2014) and reflected on in Section 4.3.5.6. After deliberation and consultation the steering committee however agreed that it would not be a requirement to make use of these methodologies and agreed on the priorities as illustrated in Table 7.21 through a process of consultation.

Table 7.21: ABC concentrator PAMSEEM action plan priorities

Action Plan	Commence	Deadline
Define and align the ABC concentratorPAMS	November 2014	January 2015
Optimize the existing PAM Organizational Design	January 2015	30 August 2015
Failure Defence Plan for critical assets	January 2015	October 2015
PAM communication strategy	August 2015	Ongoing
PAM Human Asset Register	June 2015	December 2015

7.7.1.3 Step 3 – Implement action plans

In line with the research team's understanding of the ABC concentrator environment as well as their specific skill set, the steering committee requested the team to become involved in the implementation of action plan 1. Examples of some of the documents that were developed during the implementation of all action plans are included in Appendix E. At the time of writing this document the organization was still actively involved with the implementation of the agreed plans described in Section 7.7.1.1.

7.7.2 Impact and effectiveness of the process and artefacts

It is impossible to express any validated opinion on the impact and effectiveness of action plans that were not fully implemented at the time of writing this document. In line with recommendations made in Section 6.5.4 the action planning process was however deployed in such a manner that stakeholder consensus and commitment was already confirmed during the formulation and prioritization of action plans. The implementation of the plans became the responsibility of the total cross-functional PAMSEEM implementation team, and the achievement of objectives were also incentivized on a cross-functional and

cross-departmental basis.

The action planning process in itself thus addressed a number of the fundamental factors contributing to PAMSEF, such as lack the of consensus, commitment and inter-departmental conflict.

In the same way it is not the intention of the PAMSEEM to make value judgements on the content of a given PAMS, it is not the intention of this study to evaluate the effectiveness of action plans developed during the action planning phase. In the light of the fact that the research team was directly involved with the implementation of action plan 1 the impact the implementation of this plans had on the prevention and management of Strategy Execution Failure are reflected on briefly.

During a two-day workshop the research team facilitated the development and alignment of a PAMS[1]. During the development of the PAMS the principles of the contemporary strategy design paradigm (discussed in Section 2.2.3), were duly considered and incorporated. The following principles were specifically considered:

- Primary purpose of the strategy – The steering committee accepted the fact that the fact that focus should not longer be on the development of a long-term defensible position of sustainable competitive advantage, but that within the context of the highly dynamic and unpredictable environment that the ABC concentrator operates the emphasis should be on seeking agreement and acceptance (from all stakeholders) of the broadly defined direction;
- Level of involvement – The input of all stakeholders at all levels were continuously seeked.
- Leadership role – The changes in the conception, role and deployment of employees and the idea that senior managers alone can predict the future or that they alone should dictate the content of the strategy was debunked, and the leadership played the role of process enabler and synthesizer;

The incorporation of these principles not only resulted in the clarification of direction, but more importantly also ensured consensus, understanding and acceptance of the intention of the Physical Asset Management Strategy. The operationalization of Phase 3 of the PAMSEEM thus indeed seem to have contributed to not only the early detection of PAMSEF but also the management thereof. Part one and two of the second expected outcome of the validation process is thus achieved.

7.8 Learning and feedback

In Section 6.6 it was stated that the learning and feedback phase of the PAMSEEM should not be construed as as the fourth step in a series of activities. It is rather the

[1]Examples of the documentation generated during the process is included in Appendix E.

result of efforts taken during Phase 1 – 3. Learning and feedback within the context of the PAMSEEM thus refers to the creation and more importantly the maintenance of an environment that is conducive to learning and feedback. In Section 2.4.1 it was illustrated that the learning organizations are skilled at the following activities:

1. Systems thinking;
2. Systematic problem identification;
3. Creation of a shared vision;
4. Creation and maintenance of a team learning environment;
5. Systematic problem solving and action planning; and
6. Regular reflection.

Each one of these is accompanied by a distinctive mind-set, tool kit or artefacts, and pattern of behavior. The PAMSEEM embrace all these activities. In the absence of learning, the organization will continue to repeat old practices and changes will remain cosmetic, and improvements will either be fortuitous or short-lived. The creation of a culture of learning is however an ongoing process and the PAMSEEM requires stakeholders to not only compare actual achievement with set targets (single-loop learning), but to continually question the underlying principles and values (double-loop learning) of the PAMS.

7.8.1 Operationalization and use of artefacts

The aim of the operationalization of Phase 4 is thus not just the mere completion of a number of action steps. The aim is fundamentally to ensure the continuous development of the culture of learning and feedback that was initiated during the operationlization of Phase 1 – 3, and to ensure that the culture becomes engrained in the PAM organizational lifestyle.

7.8.2 Impact and effectiveness of the process and artefacts

In this section the impact the operationalization of the PAMSEEM had on instilling the skills required to become a learning organization are illustrated.

7.8.2.1 Systems thinking

In Section 2.4.1 it was illustrated that the essence of systems thinking lies in a shift of mind and an understanding of the importance of inter-relationships rather than linear cause–and–effect chains, and seeing processes of change rather than snapshots.

The PAMSEEM embrace these principles, and the generic PAMSEEM were introduced to the steering committee as part of Phase 1 of the operationalization process. During this phase stakeholders were continuously alerted to the fact that PAMSEF is not the result of a single omission or mistake. Stakeholders were required to investigate and understand the inter-relationships that exist between all factors contributing to possible PAMSEF. The steering committees understanding of the existence and the importance of these inter-relationship is confirmed by the following extract from the PAMSEEM Statement of Direction (SoD) that was formulated at the outset of the operationalization process:

> *"The ABC concentrator accepts the reality that a number of factors prevent us from achieving our goals...We are committed to identify these factors proactively, understand their impact on the organization and on each other and are prepared to develop action plans to eradicate these factors or to minimize the possible effect they might have during the PAMSE process"*

During the development of action plans stakeholders furthermore acknowledged that the redefinition of the PAM lifestyle would require significant and ongoing effort and that it would require the commitment of all organizational stakeholders.

7.8.2.2 Systematic problem identification

During the operationalization of Phase 2 generally accepted scientific methods were applied to screen the organization and to identify and quantify the nature and prevalence of DDFs. In addition to the steering committee, a number of other stakeholders were involved during the screening and detection as well as the feedback process. The organization was also strongly recommended to repeat the screening and detection process on a regular basis (see Figure 7.5, as well as the recommendations made in the ABC concentrator PAMSEEM report presented in Table 7.15).

Stakeholders were thus at a number of times during the operationalization of the PAMSEEM exposed to, and involved in the systematic identification of problems. If the organization accept the recommendations made the skill of systematic problem identification will indeed become an important asset that stakeholders would be also be able to apply in environments outside the confines of PAM.

7.8.2.3 Creation of a shared vision

The formulation of a Statement of Direction was the first step in the creation of a shared vision (The SoD was presented in Section 7.5.1.3). In the same way that the formulation of a PAMS does not ensure effective execution, the steering committee however acknowledge the fact that the formulation of a SoD would not in itself result in a share the vision

amongst all stakeholders. For this reason a detailed communication campaign was developed and implemented (see Table 7.10). The aim of the communication campaign was to create awareness, understanding and commitment amongst all stakeholders regarding the purpose of the PAMSEEM.

No less than 20 stakeholders were not only exposed, but required to formulate a shared vision and to develop a detailed communication campaign. The skill of shared vision creation were thus instilled, and these stakeholders will in the future be able to apply these skills within the context of the PAM organization, but also in the organization at large.

7.8.2.4 Creation and maintenance of a team learning environment

The completion of a number of steps during the operationalization of the PAMSEEM contributed to the creation of a team learning environment:

- During Phase 1 of the operationalization of the PAMSEEM, the organization was required to constitute a steering committee representing all organizational stakeholders. The composition of the ABC concentrator steering committee was illustrated in Table 7.8;
- After completion of the PAMSEEM screening report it was presented to various stakeholder groups. The aim of these feedback sessions were not only to provide feedback but also to extract information from stakeholders that were used during the development of action plans. These feedback sessions were significant moments of group learning. In line with the fact that the PAMSEEM is an ongoing process, these group learning sessions should become a regular feature on the ABC concentrator calendar;
- The formation of Centres of Excellence (CoE) was one of the objectives of Action Plan 2 (See Table 7.17). During the formation of these CoE the principles of Self-Managed Team (ST)s introduced in Section 4.4.2.3[1] was applied.

The principles of team contribution and team learning are critical elements of the PAMSEEM and during its operationalization within the ABC concentrator these principles were embraced by all stakeholders.

7.8.2.5 Systematic problem solving and action planning

As indicated the final step of Phase 2 was the facilitation of a number of feedback sessions. The aim of these feedback sessions was not only to provide feedback but also to extract

[1]In an effort to ensure higher levels of flexibility and AM organizational agility Tsang (2002) suggest the formation of so-called Self-Managed Team (ST)s, which aim at creating an environment of team learning and leveraging and enhancing employees capabilities.

information from stakeholders in an attempt to tap into the tacit knowledge base that exist within the organization. The principles of joint problem solving were applied during these sessions and stakeholders from across the total organizational spectrum were exposed to these principles (See Section 7.6.1.5). In addition hereto the steering committee formulated and prioritized a number of action plans in an attempt to address to most pertinent factors contributing to PAMSEF.

The completion of these actions contributed to instilling the skill of systematic problem solving and action planning.

7.8.2.6 Regular reflection

The PAMSEEM requires the organization to reflect not only on the achievement of objectives, but more importantly on the underlying principles and values. A key element of the newly formulated PAM strategy is the reflection cycle (see Appendix E.) The reflection cycle is based on the Plan–Do–Act cycle develop by Deming and requires regular assessment of the achievement of PAM objectives, the determination of priorities and the development and implementation of improvement plans. Regular reflection is furthermore a design principle of the STs and CoEs that were formed as an outcome of the action plan 2.

7.9 Conclusion

The purpose of this Chapter 7 was to present the methodology and results of the PAMSEEM validation process. In Section 7.1 the validation design and philosophy was articulated and in Section 7.2.1 the validation objectives of this study were stated. These objectives are repeated here for ease of reference and the extent to which they were achieved are briefly evaluated.

1. To complete the validation process and to comply with all generally accepted academic standards and requirements – In Section 7.1 it was indicated that Model validation can according to Frey & Dym (2006), be viewed as a specialized topic in the epistemology and they identify four prominent views on the justification of knowledge claims. For the purpose of this study the focus fell on the validation methodologies that form part of the epistemology of practice. In his seminal work Argyris (1977) noted that researchers using these methodologies should consider the following principles, methodologies and requirements during the validation process:

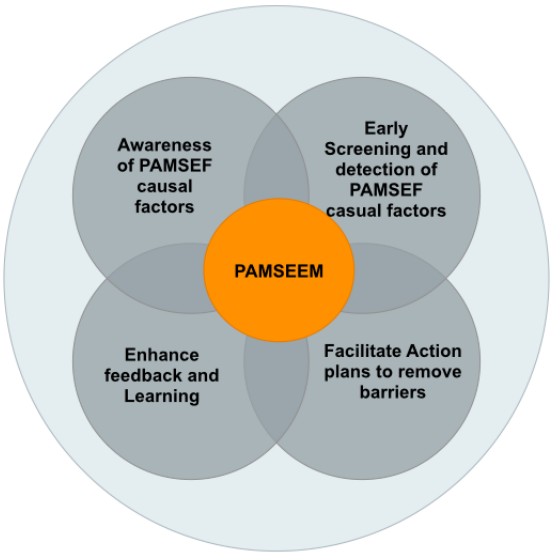
   (a) Testability of the new theory or model;

   (b) Internal consistency of the new theory of model;

   (c) Congruence between the new theory or model and espoused theory;

   (d) Effectiveness of the new model or theory

Figure 7.6: The purpose of PAMSEEM



Each on of these aspects were considered and described in this Chapter and it can thus be concluded that validation process indeed complied with all generally accpeted academic standards and requirements.

2. To describe the PAMSEEM operationalization process and the use of artefacts – The operationalization and use of artefacts of each phase of the PAMSEEM has been described in detail in Sections 7.5, 7.6 and 7.7. The achievement of the the second validation objective can thus be confirmed.

3. To illustrate in the most effective way possible that the PAMSEEM objectives were achieved during the operationalization process. – These objectives were described in the introduction to Chapter 6 and was illustrated in Figure 6.3 and is reproduced in Figure 7.6 for ease of reference.

   The contribution and impact the mechanism made to ensure increased awareness of the factors causing PAMSEF was discussed in Section 7.5.2. The contribution and impact the mechanism had on the early detection and management of possible PAMSEF has clearly been articulated and confirmed in sections 7.6.2. In Section 7.7.2 it was acknowledge that it would be impossible to express any validated opinion on the impact and effectiveness of action plans that were not fully implemented at the time of writing this document. In line with recommendations made in Section 6.5.4 the action planning process was however deployed in such a manner that stakeholder consensus and commitment was already confirmed during the formulation and prioritization of action plans. The action planning process in itself thus addressed a number of the fundamental factors contributing to PAMSEF, such as lack the of consensus, commitment and interdepartmental conflict.

In the final instance the contribution the operationalization of the PAMSEEM made to the creation of a learning organization was described and confirmed in Section7.8.2.

In Chapter 8 the focus will fall on a number of vital learnings, recommendations regarding possible future research and a number of concluding remarks.

Chapter 8

Conclusion

The purpose of this chapter is to finally conclude the study. The chapter will commence with a confirmation of achieved research results. The chapter will be concluded with a number of recommendations regarding possible future research.

8.1 Confirmation of achieved research results

This study had two primary research objectives and eight secondary objectives. The achievement of the primary objectives were however dependent on the achievement of the secondary objectives. These objectives were presented in Table 8.1 and are reproduced in Table **??** for ease of reference.

Table 8.1: Summary of the Research objectives

Chapter	No.	Objective
		Secondary Objectives
Two	1	Evaluate the body of theoretical knowledge on organizational strategy and the evolution of strategy formulation and present a framework for analysis.
Three	2	Define and contextualize the concept of Strategy Execution and by implication Strategy Execution Failure (SEF) Analyze the recent empirical and theoretical contributions regarding SEF and to summarize the limitationsand shortcomings of the existing Strategy Execution Body of Knowledge (SEBOK).
Four	3	Distill an organizational asset classification framework and develop a model illustrating how assets interact to create organizational value. An understanding of these dynamics is an essential prerequisite for the development of the PAMSEEM.

Chapter	No.	Objective
	4	Summarize the recent developments within the PAM landscape to gain an understanding of the challenges and opportunities contemporary PAM practitioners and academics are faced with.
	5	Present a framework illustrating the most important PAM strategy developments over the past 100 years within the context of the organizational strategy and within the context of contemporary strategy discourse.
Five	6	Define Physical Asset Management Strategy Execution (PAMSE) and by implication Physical Asset Management Strategy Execution Failure (PAMSEF) and analyze the recent main stream, empirical and theoretical contributions regarding PAMSE and PAMSEF, and present the limitations and shortcomings of the existing PAM SEBOK.
		Primary Objectives
Six	7	Develop a Physical Asset Management Strategy Execution Enforcement Mechanism (PAMSEEM) as well as a digestible dissemination format to address the main problem.

In the pursuit of these objectives a number of summaries, flowcharts, frameworks, artefacts and models were developed. A summary of these outputs and evidence of the fact that both the primary and secondary study objectives were achieved are presented in the next paragraphs.

Objective 1:

Evidence: The purpose of Chapter 2 was to achieve the first objective of the study. In the pursuit of achieving this objective reference was made to the following three themes:

- The origins of strategy and the development of strategy management theory;
- Strategy and organizational design; and
- Strategy and the role of Strategy– and Management Control systems.

In Section 2.1 a categorization framework was introduced and this framework as well as a summary of major theoretical contributions were presented in Table 2.9.

Status: Achieved.

Objective 2:

Evidence: In the pursuit of this objective Chapter 3 commenced with an evaluation of empirical literature on the subject of SE. This evaluation revealed the following facts.

Up to the start of the contemporary strategy period the overwhelming majority of strategy research focussed on the planning process or on the content of the strategy being formulated. As illustrated in Section 3.2.2.2 many organizations still treat the formulation and execution of strategy as separate steps. Based on the evaluation of empirical literature it was however possible to distill a definition for Strategy Execution (SE) that was presented in Section 3.1.

The literature review in Chapter 3 furthermore revealed that a number of academics and researchers have heeded the calls for research that explores the field of Strategy Execution in more detail. The analysis of the SEBOK furthermore revealed that there are mainly two streams of research:

- The first stream focuses on the identification of individual factors that influence Strategy Execution; and
- The second stream focus on the presentation of models to illustrate how individual factors interrelate to form a Strategy Execution environment.

It was however concluded that contributions on strategy formulation still far outnumber those on execution. Chapter 3 was concluded with a presentation in Section 3.3 on the the most important limitations, shortcoming and opportunities identified in the SEBOK.

Status: Achieved.

Objective 3:

Evidence: The classification of organizational asset proofed to be more complicated than anticipated. The literature review however highlighted three important aspects:

- There seem to be no comprehensive and generally accepted organizational asset classification framework.
- There seem to be no consistent way in which the value contribution of various organizational assets classes are reported on. Physical assets are for example reflected on the organizational balance sheet, while intangible assets such as technology, reputation and culture are not reflected on the balance sheet;
- Contributors seem to accept that strategy execution is strongly influenced by the interdependencies and co-operation between various asset classes. For this reason it is important to understand and map these interdependencies. There however seem to be no generally accepted model to map and illustrate these interdependencies. The BSC and more specifically strategy maps seem to be the most widely used instrument. Although strategy maps seem to be useful for mapping direct dependencies, critics are however sceptical about the effectiveness of strategy maps to also map indirect dependencies. These critics argue that the indirect dependencies should be mapped through the development of so-called Value Creation Maps (VCM)s.

The framework distilled and presented in Table 4.4 is not an attempt to address all these shortcomings, but was merely presented to provide a reference point for the purpose of this study. It should be clear that the framework acknowledges that organizational strategy is influenced by both internal and external factors. The strategy is often *"pulled"* by the external environment (market conditions and customer demands) and *"pushed"* from within (see the discussion on the *"resource based view of the firm"* in Section 2.2.2.4).

Status: Achieved.

Objective 4:

Evidence: In Section 4.5 the most recent developments within the PAM landscape were summarized. In the discussion the following important aspects were highlighted:

- Over the past decade the PAM landscape has changed dramatically. The most important implication of these changes seem to be a realization among academics and practitioners that PAM requires an integrated approach that joins bordering disciplines. The collective recognition among PAM stakeholders for the need for optimizing the mix of cost, risk and performance over the assets entire life cycle and to do so in a governable and sustainable manner, seem to be the biggest catalyst for the changes in the landscape;
- The recognition for the need to change led to a number of attempts in the last decade to standardize the field. These attempts led to the all important publication of the ISO 55000 standard in 2014. ISO 55000 is the the first set of international standards for asset management;
- In addition to the ISO 55000 standards the Institute for Asset Management (IAM) described the overall scope of AM. The IAM model identifies six AM subject groups. The model also highlights the fact that AM is about the integration of these groups of activities and not just the activities in isolation.

The achievement of this objective was important in order to gain an understanding of the challenges and opportunities contemporary PAM practitioners and academics are faced with.

Status: Achieved.

Objective 5:

Evidence: In Section 4.4 the most important PAM strategy developments over the part 100 years were juxtaposed with developments in the field of general business strategy development. In the framework the following aspects were specifically highlighted:

- There is a very strong correlation between developments within general business and strategy management discourse and the developments within the PAM discourse. Contributors within the PAM discipline however seem to be reactive and typically do not dictate the strategy management agenda. Perceptions regarding the role of

PAM has evolved from *"necessary evil"* in the 1940s to *"positive cooperation"* post 2000. The evolution should however been seen as a reaction to developments within the business world;

- Prior to 2000 there is very little or no reference to PAM *per se*. Most if not all literature in the period 1940–2000 referred to Maintenance Management. Any reference to Maintenance Management prior to 2000 was for the purpose of analysis regarded as reference to PAM;

- The dominant strategy discourse of the late 1980s and early 1990's revolved around the *"resource based view of the firm"*. This view had a major impact on the way in which organizations approached the formulation of strategy. Up to this point conventional approaches to competitive advantage focused upon so-called generic sources of competitive advantage – namely cost and differentiation advantage. The contention was thus that organizations perform better and create more value when they implement strategies that are responsive to market conditions. Exponents of the resource based view of the firm contended that the firm itself, in terms of its resources an capabilities may be a far more sustainable basis to define strategy. It is thus no co-incidence that perceptions regarding PAM evolved in this period from *"technical specialization"* to *"profit contributor"*.

- There is also strong correlation between organizational design principles within the PAM discipline and general organizational design principles. In this regard it is noteworthy that some progressive PAM contributors for example recommend the implementation of Agile organization design principles. These principles include multi-skilling, the implementation of Self Managed Teams and Centres of Excellence. The reality however is that most PAM organizations still seem to embrace bureaucratic organization design principles based on the ideas of Taylor and Weber;

- Strategic and management control systems provide information that is intended to be useful to managers in performing their jobs and to assist organizations in developing and maintaining viable patterns of behaviour. The literature review confirms that a large variety of management control systems and artefacts are used within the contemporary organization. Contributors are also continuously applying these principles to the field of PAM. To ensure the achievement of strategic, tactical as well as operational PAM goals, the PAM MCS however need to be far more inclusive and the performance measures should be linked to the strategy of the PAM function and the PAM MCS should be linked to the strategy of the organization in order to get the maximum impact.

In Section 2.5 it was concluded that many of the developments in the application of strategy is the result of changes in the very nature of competition and operations between and within businesses. It was thus illustrated that the relationship between strategy theory development and business operation is clearly Hegelian in nature. It was however also pointed out that it was sometimes difficult to identify if changes in strategy

management theory patterns is the result of changes in the nature of business or vice versa. The literature review of PAM strategy developments however clearly illustrate that PAM strategy development seem to be far more reactive and that PAM strategy contributors typically do not dictate the strategy management agenda. These conclusion provided valuable insights that were continuously considered during the development of the PAMSEEM.

Evidence: Despite the fact that limited publications could be found on PAMSE specifically the concept was defined in Section 5.1. The definition was based on the definition of Contemporary Physical Asset Management (CPAM) defined in Section 4.3.1, the definition of Physical Asset Management Strategy defined in Section 4.4.1.3 and the definition of Strategy Execution defined in Section 3.1.

Status: Achieved.

Objective 6:

Evidence: In the pursuit of this objective the framework developed by Yang *et al.* (2009), on factors contributing to SEF in general and introduced in Chapter 3, were used. The conclusion reached at the end of this evaluation was that despite the fact that very few peer reviewed publications dealing specifically with the challenges involved in PAMSE could be found it is important to note that there is strong coherence and correlation between the findings and recommendations made in other peer reviewed literature on PAM, and findings made on SE in general (discussed in detail in Chapter 3).

In Section 5.2.2 three prominent instances of PAM SEF were evaluated. The impact of PAM SEF was clearly illustrated in each on of these case studies.

In order to assist in the evaluation process a scorecard, based on the definition of PAMSE developed in Section 5.1, was presented. The scorecard consists of four components namely:

- The importance of alignment between the PAMS and the OSP;
- The importance of Organizational Design and by implication also the availability of the right skills and competence as well as the availability and applicability of Strategy Control System and Management Control Systems.
- The importance of interpersonal readiness; and
- The extent to which PAs contributes to the creation of sustainable competitive advantage.

During the development of the screening instrument that forms an integral part of the PAMSEEM these aspects were considered specifically.

Status: Achieved.

Objective 7:

Evidence: Objective 7 are considered to be the primary study objective. The achievement of Objective 7 was pursued in Chapter 6 and 7. In the the pursuit of this objective the following aspects were addressed. The chapter commenced with a brief introduction to the PAMSEEM, whereafter the proposed operationalization process was presented. Thereafter each one of the components of the PAMSEEM was introduced in detail. The mechanism was theoretically grounded through regular reference to the empirical literature review presented in Chapters 2, 3, 4 and 5. The chapter was concluded with a summary of the anticipated value contribution of the mechanism.

Chapter 7 commenced with a description of the validation design and philosophy and methodology. This was an extension of the presentation of the research strategy and methodology presented in Chapter 1. Thereafter the expected outcomes of the validation process were discussed with a full recognition and understanding of the delimitations and limitations of the study presented in Chapter 1. That lead to a description of the chosen validation context and landscape. An abridged version of some of the most critical observations made during the research process were presented, before the PAMSEEM operationalization process was discussed in detail. The operationalization of each one of the components of the PAMSEEM was presented separately. The value contribution of each one of the components were discussed as part of the conclusion of each section. In Section 1.5, it was indicated that, unlike empirical research where it would be possible to quantify the extent to which validation objectives were met, the nature of the validation objectives of this study required a more qualitative approach. For this reason the application impact had to be determined through amongst other methods feedback from senior organizational leadership as well as other anecdotal evidence. Based on the presentation of evidence discussed throughout Chapter 7 it was however concluded that the PAMSEEM was successfully validated within the context of a highly PA dependent organization.

Status: Achieved.

From the central research problem, this dissertation had the aim to reject the null hypothesis presented in Section 1.2 and reproduced here for ease of reference.

H_0 *It would not be possible to develop a Physical Asset Management Strategy Execution Enforcement Mechanism that would assist academics and practitioners with the early detection and management of Physical Asset Management Strategy Execution Failure.*

Based on the above discussion it is concluded that it was indeed possible to develop a Physical Asset Management Strategy Execution Enforcement Mechanism that would assist academics and practitioners with the early dedection and management of Physical Asset Management Strategy Execution Failure, and that the H_0 was rejected.

8.2 Lessons learned

In line with the characteristics of case study research identified by Yin (2013) and referred to in Section 7.1, the aim of case study research is not only to explore certain phenomena, but to understand them within a certain context. For this reason it was important to gain an in-depth understanding of all PAM practices within the context of the ABC concentrator.

In order to achieve this objective it was agreed that a PAM assessment, during which all aspects of the PAM practices and principles were evaluated and burning platforms identified, had to be conducted prior to the operationalization of the PAMSEEM.

Although the completion of an organizational audit is not a prerequisite for the implementation of the PAMSEEM the information gained through the process is extremely useful. It is thus recommended that academics and practitioners that attempt to implement the PAMSEEM in other environments should also consider to gain and in-depth understanding of PAM practices and procedures prior to the deployment of the mechanism.

Eisenhardt (1989a) make special mention of the use of multiple investigators during the data collection and validation process of case study research. Multiple investigators have according to her two key advantages:

1. They enhance the creative potential of the study; and
2. The convergence of observations from multiple investigators enhances confidence in the findings.

The use multiple investigators during the completion of the PAM assessment as well as during the operationalization of the PAMSEEM was found to be extremely useful. The observations made by Eisenhardt (1989a) can thus be confirmed and it is recommended that of an team of experienced researchers and field workers should be used during the operationalization of the PAMSEEM.

8.3 Recommendations for possible future research

In this final section reference will be made to a number of recommendations for future research as well as a number of lessons learned during the course of the study.

In Section 1.2 a number of research problems were highlighted. These included:

1. The fact that the relationship between organizational performance and strategy execution are often misunderstood;

2. The non-existence of a clearly defined and universally accepted definition forStrategy Execution and by implication Strategy Execution Failure;

3. Despite that fact that researchers have identified a number of factors leading to SEF, very few studies seem to have explored the relationships and correlations between these factors;

4. No clearly defined and universally accepted definition for Physical Asset Management Strategy Execution (PAMSE) and by definition Physical Asset Management Strategy Execution Failure (PAMSEF) exists;

5. There is no universal agreement on the factors that lead to PAMSEF;

6. There is not mechanism that can assist PAM practitioners and academics with the early detection and management of PAMSEF

Despite the temptation to attempt to address all the problems the research scope in this study was tapered down in line with the understanding that the effective management of Physical Assets are becoming increasingly important and because it would have been both impractical and academically irresponsible to attempt to address all these problems in one research study.

The focus of this study was to find answers to the latter three research problems and the achievement of this objective was evaluated in Section 8.1.

The seemingly spurious relationship that exists between Strategy Execution and organizational performance was not evaluated in detail in this study. The point was however clearly made that unless a clear distinction is made between organizational performance and the extent to which strategies are effectively executed the cycle of endless formulation-implementation-performance will ultimately result in attempts at implementing a wrong strategy. When this happens, it is difficult to determine if poor performance is due to good implementation of a bad strategy, or the result of poor implementation of a good strategy. It is thus *firstly* recommended that this relationship should be evaluated in far more detail.

Although a definition for PAMSE and by implication PAMSEF was provided in Chapter 5 of this study, no claims are made that this definition is universally applicable to all forms of Strategy Execution Failure. It would thus *secondly* recommended that future SE research efforts should focus on finding a more universally accepted definition for SE.

In this study a number of factors (DDFs), contributing to PAMSEF were identified and described. In the light of the nature and extent of the study it was however not possible to explore or define the dynamics and the existence of possible correlations between various Deadly Dectet Factors. It is *thirdly* recommended that these dynamics should be evaluated in more detail. This could possible happen through the completion of a longitudinal study;

In Section 7.2.2 it was noted that the evaluation of the impact and effectiveness of the operationalization of the Awareness phase of the PAMSEEM was compromised because it was not possible to establish an experimental control environment prior to the operationalization and that a yard stick for the measurement of organizational awareness of PAMSEF causal factors did not exist prior to the study. The implication of these factors were thus that it was impossible to quantify the impact the operationalization of the PAMSEEM had on increased PAMSEF causal factor awareness levels. It is *forthly* strongly recommended that a yard stick to develop awareness of casual factors should be developed;

In the same way that no claims are made that the definition for PAMSE provided in Chapter 5 is universally appicable to all forms of SEF, no claims are made that the operationalization of the PAMSEEM will assist with the early identification and management of SEF in disciplines outside the domain of Physical Asset Management. It is however *finally* recommended that the principles established in this study should be contextualized and the applicability and usefulness of the mechanism should be evaluated in other business domains as well.

End.

Bibliography

AASHTO (2015). Transportation asset management guide - a focus on implementation,, american Association of State Highway and Transportation Officials. 175

Abrahamson, E. (1996). Management fashion. *Academy of management review*, **21**, 254–285. 70

Achenbach, J. and Hilzenrath, D. (2010). Lawyers take over spill enquiry. *Washington Post*. 182, 183

Adenfelt, M. and Lagerström, K. (2008). The development and sharing of knowledge by centres of excellence and transnational teams: A conceptual framework. *Management International Review*, **48**, 319–338. 160

Akan, O., Allen, R.S., Helms, M.M. and Spralls III, S.A. (2006). Critical tactics for implementing porter's generic strategies. *Journal of Business Strategy*, **27**, 43–53. 98, 180

Alazraki, M. (2010). Did transocean's neglect of deepwater horizon rig maintenance cause gulf oil spill? *Daily Finance.com*. 182, 183

Alcamo, I.E. and Warner, J.M. (2010). *Schaum's Outline of Microbiology*. McGraw-Hill. 24

Alexander, L.D. (1985). Successfully implementing strategic decisions. *Long Range Planning*, **18**, 91–97. 82, 84, 88, 89, 92, 94, 95, 97, 100, 179

Alexander, P. (2013). *Marikana: A view from the mountain and a case to answer*. Jacana Media. 267

Allio, M.K. (2005). A short, practical guide to implementing strategy. *Journal of Business Strategy*, **26**, 12–21. 87, 92

Alsyouf, I. (2006). Measuring maintenance performance using a balanced scorecard approach. *Journal of Quality in Maintenance Engineering*, **12**, 133–149. 73

Amadi-Echendu, J. (2004). The paradigm shift from maintenance to physical asset management. *IEEE Transactions on Engineering Management*. 6, 111, 122, A-1

Amadi-Echendu, J.E., Willett, R., Brown, K., Hope, T., Lee, J., Mathew, J., Vyas, N. and Yang, B. (2010). What is engineering asset management? In *Definitions, Concepts and Scope of Engineering Asset Management*, 3–16, Springer. 7, 117, 122, 138, 158, 159, 175, 177, 178

Amnesty-International (2015). Nigeria: Hundreds of oil spills continue to blight niger delta. *Amnesty International*. 186

Andrews, K. (1971). *The Corporate Strategy*. Irwing. 28, 147

Ansoff, H.I. (1957). Strategies for diversification. *Harvard business review*, **35**, 113–124. 26, 29, 145

Ansoff, H.I. (1965). *Corporate strategy: business policy for growth and expansion*. McGraw-Hill Book. 30

Anthony, R. (1965). *Planning and Global Systems: A Framework for Analysis.*. Boston Division of Research, Graduate School of Business Administration, Harvard University. 54, 55, 56, 66, 133, 161, 162

Antony, J. and Banuelas, R. (2002). Key ingredients for the effective implementation of six sigma program. *Measuring Business Excellence*, **6**, 20–27. 74

Argyris, C. (1977). Double loop learning in organizations. *Harvard business review*, **55**, 115–125. 51, 240, 250, 303

Argyris, C. (1991). Teaching smart people how to learn. 51, 240, 250

Armstrong, M. and Taylor, S. (2014). *Armstrong's handbook of human resource management practice*. Kogan Page Publishers. 147

Atkinson, H. (2006). Strategy implementation: a role for the balanced scorecard? *Management Decision*, **44**, 1441–1460. 73, 74

Bajwa, S. (2014). Apple v. samsung: Is it time to change our patent trial system? *Pac. McGeorge Global Bus. & Dev. LJ*, **27**, 77–153. 38

Bam, W.G. and Vlok, P.J. (2014). Optimising invesment in asset management using the multivariate asset management assessment topography. *South African Journal of Industrial Engineering*, **25**, 29–38. 140, 238, 298

Banker, R.D., Chang, H. and Pizzini, M. (2011). The judgmental effects of strategy maps in balanced scorecard performance evaluations. *International Journal of Accounting Information Systems*, **12**, 259–279. 73, 74

Barnard, C. (1938). 1.1938. the functions of the executive. *Cambridge/Mass*. 98

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, **17**, 99–120. 2, 36, 39, 41, 79, 116, 147

Barney, J.B. (1986). Organizational culture: can it be a source of sustained competitive advantage? *Academy of management review*, **11**, 656–665. 39

Bartlett, C. and Ghoshal, S. (2013). Building competitive advantage through people. *Sloan Mgmt. Rev*, **43**. 138

Baum, J. and Vlok, P.J. (2013). Mapping primary constraints in physical asset management strategy execution, using social network analysis. *South African Journal of Industrial Engineering*, **24**, 47–58. 7, 8, 171, 173, 174, 178, 179

Becker, G.S. (1964). Human capital: a theoretical analysis with special reference to education. *National Bureau for Economic Research, Columbia University Press, New York and London*. 119

Bender, B.G. (2002). Overcoming barriers to nonadherence in asthma treatment. *Journal of Allergy and Clinical Immunology*, **109**, S554–S559. 235

Bender, R. (2013). *Corporate financial strategy*. Routledge. 117

Berry, A.J., Broadbent, J. and Otley, D.T. (1995). *Management control: theories, issues, and practices*. Macmillan. 56

Berry, A.J., Coad, A.F., Harris, E.P., Otley, D.T. and Stringer, C. (2009). Emerging themes in management control: A review of recent literature. *The British Accounting Review*, **41**, 2–20. 63

Bisbe, J., Batista-Foguet, J.M. and Chenhall, R. (2007). Defining management accounting constructs: a methodological note on the risks of conceptual misspecification. *Accounting, organizations and society*, **32**, 789–820. 60

Blanchard, B.S. and Fabrycky, W.J. (1998). Systems engineering andanalysis. *UpperSaddle River, NJ: Prentice-Hall. problem solving: a prelude to quantitative analysis, IEEE transactions on systems, man and cybernetics*, **23**, 746–765. 135

Boer, H., Drejer, A., Minarro-Viseras, E., Baines, T. and Sweeney, M. (2005). Key success factors when implementing strategic manufacturing initiatives. *International Journal of Operations & Production Management*, **25**, 151–179. 93

Boulding, K.E. (1956). General systems theory-the skeleton of science. *Management science*, **2**, 197–208. 13

Bourgeois, L.J. and Brodwin, D.R. (1984). Strategic implementation: Five approaches to an elusive phenomenon. *Strategic Management Journal*, **5**, 241–264. 98, 99

Bracker, J. (1980). The historical development of the strategic management concept. *Academy of Management Review*, **5**, 219–224. 25, 26

Branham, L. (2012). *The 7 hidden reasons employees leave: How to recognize the subtle signs and act before it's too late*. AMACOM Div American Mgmt Assn. 97

Braverman, H. (1998). *Labor and monopoly capital: The degradation of work in the twentieth century*. NYU Press. 45, 53, 154

Brenes, E.R., Mena, M. and Molina, G.E. (2008). Key success factors for strategy implementation in latin america. *Journal of Business research*, **61**, 590–598. 101, 102, 103

Brewer, P.C., Garrison, R.H., Noreen, E.W., Liu, H. and Wang, M. (2008). *Introduction to managerial accounting*. McGraw-Hill/Irwin. 69, 70

Bruns, W.J. and Kaplan, R.S. (1987). *Accounting & management: field study perspectives*. Harvard Business Press. 69

BSI (2008). *Public Available Specification 55 Part 1: Specification for the optimized management of physical assets.*. The Institute of Asset Management. 113

Buchanan, S. (2013). Transocean denies skimping on deepwater horizon maintenance. *The Huffington Post*. 182, 183

Burns, A.C. and Bush, R.F. (2006). Marketing research. *Globalization*, **1**. 140

Butler, R. (1991). *Designing organizations: a decision-making perspective*. Routledge London. 49

Campbell, J.D. and Reyes-Picknell, J. (1995). Strategies for excellence in maintenance management. *Productivity Prsee Portland, Oregon pages-185*. 162

Capra, F. (1996). The web of life: A new synthesis of life and matter. *London, Flamingo*. 49

Cespedes, F.V. and Piercy, N.F. (1996). Implementing marketing strategy. *Journal of Marketing Management*, **12**, 135–160. 85

Chandler, A.D. (1962). *Strategy and Structure: Chapters in History of the Industrial Enterprises.*. The MIT Press, Cambridge Mass. 28, 46

Chandler, A.D. (1969). The structure of american industry in the twentieth century: a historical overview. *Business History Review*, **43**, 255–298. 26

Charan, R., Bossidy, L. and Burck, C. (2012). *Execution: the discipline of getting things done*. Random House. 87

Checkland, P. (1981). *Systems Thinking, Systems Practice*. John Wiley & Sons, Chichester, UK. 50

Chenhall, R.H. (2003). Management control systems design within its organizational context: findings from contingency-based research and directions for the future. *Accounting, organizations and society*, **28**, 127–168. 53, 60

Chimhanzi, J. (2004). The impact of marketing/hr interactions on marketing strategy implementation. *European Journal of Marketing*, **38**, 73–98. 92, 178

Chimhanzi, J. and Morgan, R.E. (2005). Explanations from the marketing/human resources dyad for marketing strategy implementation effectiveness in service firms. *Journal of Business Research*, **58**, 787–796. 92, 178

Cholasuke, C., Bhardwa, R. and Antony, J. (2004). The status of maintenance management in uk manufacturing organisations: results from a pilot survey. *Journal of Quality in Maintenance Engineering*, **10**, 5–15. 148, 149

Clegg, S.R., Clegg, S. and Hardy, C. (1999). *Studying organization: theory and method*. Sage. 48, 157

Collier, P.M. (2005). Entrepreneurial control and the construction of a relevant accounting. *Management Accounting Research*, **16**, 321–339. 60

Connor, G. and Korajczyk, R.A. (2003). Risk management in asset management. *The Growth of Risk Management: A History*. 139

Cooke, S. and Slack, N. (1991). *Making management decisions*, vol. 199. Prentice Hall Englewood Cliffs, NJ. 68

Covey, S. (1989). The seven habits of highly successful people. *Fireside/Simon & Schuster*. 106

Crittenden, V.L. and Crittenden, W.F. (2008). Building a capable organization: The eight levers of strategy implementation. *Business Horizons*, **51**, 301–309. 3, 4, 82, 83, 85, 86, 90, 101, 173

Cross, M. (1988). Raising the value of maintenance in the corporate environment. *Management Research News*, **11**, 8–11. 5, 150

Cyert, R.M., March, J.G. *et al.* (1963). A behavioral theory of the firm. *Englewood Cliffs, NJ*, **2**. 85, 98

Davis, J. (2007). What is asset management and where do you start? *Journal American Water Works Association*, **99**, 26–+. 123, 130

De Giorgi, G. and Pellizzari, M. (2014). Understanding social interactions: Evidence from the classroom. *The Economic Journal*, **124**, 917–953. 160

De Mooij, M. (2013). *Global marketing and advertising: Understanding cultural paradoxes*. Sage Publications. B-2

Dean, J.W. and Sharfman, M.P. (1996). Does decision process matter? a study of strategic decision-making effectiveness. *Academy of management journal*, **39**, 368–392. 3, 84, 172, 200

Dearden, J. (1969). Case against roi control. *Harvard Business Review*, **47**, 124. 72

Dearden, J. (1987). Measuring profit center managers. *Harvard Business Review*, **65**, 84–88. 72

Dekker, R. (1996). Applications of maintenance optimization models: a review and analysis. *Reliability Engineering & System Safety*, **51**, 229–240. 5, 150

Dent, J.F. (1991). Accounting and organizational cultures: a field study of the emergence of a new organizational reality. *Accounting, Organizations and Society*, **16**, 705–732. 53, 56

Denzin, N.K. (2012). Triangulation 2.0. *Journal of Mixed Methods Research*, **6**, 80–88. 251

Dierickx, I. and Cool, K. (1989). Asset stock accumulation and sustainability of competitive advantage. *Management science*, **35**, 1504–1511. 119

Disco, C. and Van der Meulen, B. (1998). *Getting new technologies together: Studies in making sociotechnical order*, vol. 82. Walter de Gruyter. 64

Dobbs, R., Fiorini, R., Leke, A., Thompson, F. and Wright, D. (2014). Nigeria's renewal: Delievering inclusive growth in africa's largest economy. *McKinsey Global Institute*. 189

Donavan, J. (2015). Oil spill from shells seibou well in bayelsa traced to equipment failure. *Royal Ductch Shell plc.com*. 186

Dooley, R.S., Fryxell, G.E. and Judge, W.Q. (2000). Belaboring the not-so-obvious: Consensus, commitment, and strategy implementation speed and success. *Journal of management*, **26**, 1237–1257. 96, 179

Dosi, G., Nelson, R.R. and Winter, S.G. (2000). Introduction: The nature and dynamics of organizational capabilities. *The nature and dynamics of organizational capabilities*, **1**, 24. 118

Douglas, S.P. and Craig, C.S. (2011). Convergence and divergence: Developing a semiglobal marketing strategy. *Journal of International Marketing*, **19**, 82–101. B-2

Drucker, P.F. (1954). The practice of management. *New York*, 9–10. 54

Drucker, P.F. (1994). The theory of business. *Havard Business Review*, **September - October**. 48, 157

Dunn, S. (1996). A framework for achieving best practice in maintenance. In *a conference paper presented to the West Australian Maintenance Conference*. 148

Dwight, R. and El-Akruti, K.O. (2009). The role of asset management in enterprise strategy success. 136

Eisenhardt, K.M. (1989a). Building theories from case study research. *Academy of management review*, **14**, 532–550. 15, 17, 313

Eisenhardt, K.M. (1989b). Building theories from case study research. *Academy of management review*, **14**, 532–550. 251

Eisenhardt, K.M. and Brown, S.L. (1998). Competing on the edge: strategy as structured chaos. *Long Range Planning*, **31**, 786–789. 17, 42

Eisenhardt, K.M. and Graebner, M.E. (2007). Theory building from cases: opportunities and challenges. *Academy of management journal*, **50**, 25–32. 15, 16, 17

Eisenstat, M. and Beer, I.R.A. (2000). The silent killers of strategy implementation and learning. *Sloan Management Review*. 4, 83, 89, 90, 101, 102, 103, 104, 215

El-Akruti, K.O. (2012). The strategic role of engineering asset management in capital intensive organisations. 142

Falbe, C.M. and Yukl, G. (1992). Consequences for managers of using single influence tactics and combinations of tactics. *Academy of Management Journal*, **35**, 638–652. 99

Fama, E.F. (1970). Efficient capital markets: A review of theory and empirical work*. *The journal of Finance*, **25**, 383–417. 112

Fama, E.F. (1998). Market efficiency, long-term returns, and behavioral finance. *Journal of financial economics*, **49**, 283–306. 112

Ferreira, A. and Otley, D. (2009). The design and use of performance management systems: An extended framework for analysis. *Management Accounting Research*, **20**, 263–282. 53, 56, 60, 62, 63, 73

Floyd, S.W. and Wooldridge, B. (1992). Managing strategic consensus: the foundation of effective implementation. *The Executive*, **6**, 27–39. 82, 96, 180, 239

Floyd, S.W. and Wooldridge, B. (1997). Middle managements strategic influence and organizational performance. *Journal of Management Studies*, **34**, 465–485. 94, 95, 96, 179

Fogel, G. (2013). Pragmatic implementation of pas 55. *Gausian Website*. 175, 179

Foreman, J. and Argenti, P.A. (2005). How corporate communication influences strategy implementation, reputation and the corporate brand: an exploratory qualitative study. *Corporate Reputation Review*, **8**, 245–264. 95, 179

Frey, D.D. and Dym, C.L. (2006). Validation of design methods: lessons from medicine. *Research in Engineering Design*, **17**, 45–57. 250, 303

Frolov, V., Mengel, D., Bandara, W., Sun, Y. and Ma, L. (2010). Building an ontology and process architecture for engineering asset management. In *Engineering Asset Lifecycle Management*, 86–97, Springer. 142

Furst, S.A. and Cable, D.M. (2008). Employee resistance to organizational change: managerial influence tactics and leader-member exchange. *Journal of Applied Psychology*, **93**, 453. 99

Gamal Aboelmaged, M. (2010). Six sigma quality: a structured review and implications for future research. *International Journal of Quality & Reliability Management*, **27**, 268–317. 75

Garg, A. and Deshmukh, S. (2006a). Maintenance management: literature review and directions. *Journal of Quality in Maintenance Engineering*, **12**, 205–238. 73, 164

Garg, A. and Deshmukh, S. (2006b). Maintenance management: literature review and directions. *Journal of Quality in Maintenance Engineering*, **12**, 205–238. 138, 146

Garg, A. and Deshmukh, S. (2012). Designing balanced scorecard for multi echelon repair inventory systems. *Journal of Modelling in Management*, **7**, 59–96. 164

Gause, G. (1935). Experimental demonstration of volterra's periodic oscillation in the numbers of animals. *J. exp. Biol*, **12**, 44–48. 24

Gersick, C.J. (1994). Pacing strategic change: The case of a new venture. *Academy of management journal*, **37**, 9–45. 17

Ghemawat, P. (2001). *Strategy and the business landscape: Core concepts*. Prentice Hall. 27, 29, 31, 33, 35, 36

Ghezzi, A. (2013). Revisiting business strategy under discontinuity. *Management Decision*, **51**, 1326–1358. 2, 41, 48, 79, 157, 158

Ghosh, S. (2011). Management of non-performing assets in public sector banks: Evidence from india. In *International Conference on Management (ICM 2011) Proceeding*, 2011-057-173, Conference Master Resources. 112

Gill, F., Slikas, B., Sheldon, F.H. and Fleischer, R. (2005). Phylogeny of titmice (paridae): Ii. species relationships based on sequences of the mitochondrial cytochrome-b gene. *The Auk*, **122**, 121–143. 25

Goding, J. and Hammer, M. (2001). Putting six sigma in perspective. *Quality*, **40**, 58–62. 75

Gold, R. and Casselman, D. (2010). On doomed rig's last day, a divisive change of plan. *The Wall Street Journal*. 182, 183

Gordon, G.G. and DiTomaso, N. (1992). Predicting corporate performance from organizational culture*. *Journal of management studies*, **29**, 783–798. 118

Gorry, G.A. and Morton, M.S.S. (1971). *A framework for management information systems*, vol. 13. Massachusetts Institute of Technology. 64, 66, 133

Gosselin, M. (1997). The effect of strategy and organizational structure on the adoption and implementation of activity-based costing. *Accounting, Organizations and Society*, **22**, 105–122. 69, 70

Grant, R.M. (2010). *Contemporary Strategy Analysis: Text Only*. John Wiley and Sons. 28, 29, 30, 31, 32, 34, 35, 36, 37, 38, 39, 46, 48, 49, 113, 114, 115, 116, 117, 138, 146, 157, 160

Grindley, P.C. and Teece, D.J. (1997). Managing intellectual capital: licensing and cross-licensing in semiconductors and electronics. 117

Gulati, R., Puranam, P. and Tushman, M. (2012). Meta-organization design: Rethinking design in interorganizational and community contexts. *Strategic Management Journal*, **33**, 571–586. 138

Guth, W.D. and MacMillan, I.C. (1986). Strategy implementation versus middle management self-interest. *Strategic Management Journal*, **7**, 313–327. 97, 98

Hage, J. and Powers, C. (1992). *Post-industrial lives: Roles and relationships in the 21st century*. Sage. 48, 157, 158

Hall, R. (1989). The management of intellectual assets: a new corporate perspective. *Journal of General Management*, **15**, 53–68. 117

Hall, R. (1992). The strategic analysis of intangible resources. *Strategic management journal*, **13**, 135–144. 119

Hameed, A. and Khan, F. (2014). A framework to estimate the risk-based shutdown interval for a processing plant. *Journal of Loss Prevention in the Process Industries*, **32**, 18–29. 136

Harrington, R.J. (2006). The moderating effects of size, manager tactics and involvement on strategy implementation in foodservice. *International Journal of Hospitality Management*, **25**, 373–397. 93, 100

Hartnell, C.A., Ou, A.Y. and Kinicki, A. (2011). Organizational culture and organizational effectiveness: a meta-analytic investigation of the competing values framework's theoretical suppositions. *Journal of Applied Psychology*, **96**, 677. 118

Haspeslagh, P. (1982). Portfolio planning-uses and limits. *Harvard Business Review*, **60**, 58–73. 31

Hastings, N.A.J. (2010). *Physical asset management*. Springer. 122, 138, 151

Heide, M., Grønhaug, K. and Johannessen, S. (2002). Exploring barriers to the successful implementation of a formulated strategy. *Scandinavian Journal of Management*, **18**, 217–231. 100

Henderson, B. (1989). The origin of strategy. *Harvard business review*, **67**, 139–143. 25, 26, 27, 29

Henderson, B.D. (1979). The product portfolio: growth share matrix of the boston consulting group. *The strategy process: Concepts, contexts, cases*, 678–680. 31

Henri, J.F. (2006). Management control systems and strategy: a resource-based perspective. *Accounting, organizations and society*, **31**, 529–558. 53, 56

Heracleous, L. (2000). The role of strategy implementation in organization development. *Organization Development Journal*, **18**, 75–86. 97, 100

Higgins, J.M. (2005). The eight ss of successful strategy execution. *Journal of Change Management*, **5**, 3–13. 101, 102, 103

Hinkin, T.R. and Schriesheim, C.A. (1990). Relationships between subordinate perceptions of supervisor influence tactics and attributed bases of supervisory power. *Human Relations*, **43**, 221–237. 99

Hodges, N. (1996). *The economic management of physical assets*. Mechanical Engineering Publications. 117

Hoerl, R.W. and Snee, R. (2010). Statistical thinking and methods in quality improvement: A look to the future. *Quality Engineering*, **22**, 119–129. 74

Hofstede, G., Hofstede, G.J. and Minkov, M. (1997). *Cultures and organizations*. McGraw-Hill New York. 63

Hogan, C.M. (2013). Niger river. *Encyclopedia of Earth, Washington, DC: National Council for Science and Environment*. 185

Hrebiniak, L. (2008). Making strategy work: Overcoming the obstacles to effective execution. *Ivey Business Journal*, **72**, 1–6. 82, 86, 100, 173

Hrebiniak, L.G. and Joyce, W.F. (1985). Organizational adaptation: strategic choice and environmental determinism. *Administrative science quarterly*, 336–349. 85, 92, 100

Hrebiniak, L.G. and Snow, C.C. (1982). Top-management agreement and organizational performance. *Human Relations*, **35**, 1139–1157. 93

Hubbard, D.W. (2009). *The failure of risk management: why it's broken and how to fix it*. John Wiley and Sons. 139

Hussey, J. and Hussey, R. (1997). Business research. *A practical guide for undergraduate and postgraduate students. Houndsmills: Macmillan*. 251

IAM (2011). An anatomy of asset management. *The Institue of Asset Management*. 6, 122, 127, 128, 129, 130, 131, 134, 135, 137, 138, 139, 151, 171, 173, 178, 180, 203

ISO (2009). Iso 31000. *The International Standards Organization*. 138

ISO (2014). Iso 55000. *International Standards Organization*. 5, 113, 123, 124, 126, 134, 172, 178

Itami, H. and Roehl, T. (1987). Mobilizing invisible assets,. *Harvard Business School Press, Cambridge, MA*. 118, 119

Jaafari, A. (2001). Management of risks, uncertainties and opportunities on projects: time for a fundamental shift. *International Journal of Project Management, Volume 19, Issue 2*. 138, 139

Jackson, K.T., Keller, L. and Flood, N. (2010). *The Encyclopedia of New York City*. Yale University Press. 54

Jackson, M. (2000). *Systems approaches to management*. Kluwer/Plenum, New York. 50

Jackson, M.C. (2010). *Systems thinking: Creative holism for managers*. John Wiley & Sons. 50, 51

Johnson, H.T. and Kaplan, R.S. (1987). The rise and fall of management accounting. *Engineering Management Review, IEEE*, **15**, 36–44. 72

Johnson, L.K. (2004). Execute your strategy without killing it. *Harvard Management Update*, **9**, 3–6. 3, 82, 87

Kaplan, R.S. and Norton, D.P. (1996a). *The balanced scorecard: translating strategy into action*. Harvard Business Press. 72, 73

Kaplan, R.S. and Norton, D.P. (1996b). Using the balanced scorecard as a strategic management system. *Harvard business review*, **74**, 75–85. 51, 72, 240

Kaplan, R.S. and Norton, D.P. (2000). *Having trouble with your strategy?: Then map it*. Harvard Business School Publishing Corporation. 120, 121

Kaplan, R.S. and Norton, D.P. (2005). *Creating the Office of Strategy Management*. Division of Research, Harvard Business School. 3, 82, 87

Kaufmann, W.A. (1978). *Hegel: A reinterpretation*. University of Notre Dame Press South Bend. 27

Keats, B. and O'Neill, H.M. (2001). Organizational structure: Looking through a strategy lens. 44, 46, 154

Keen, P.G. and Morton, M.S.S. (1978). *Decision support systems: an organizational perspective*, vol. 197. Addison-Wesley Reading, MA. 64

Keller, K.L. and Lehmann, D.R. (2003). How do brands create value? *Marketing Management*, **12**, 26–31. 118

Kellermanns, F.W., Walter, J., Lechner, C. and Floyd, S.W. (2005). The lack of consensus about strategic consensus: advancing theory and research. *Journal of Management*, **31**, 719–737. 95, 179

Kellick, P. (2010). Developing a strategic asset management framework. *Proceedings of the ICE-Municipal Engineer*, **163**, 221–224. 158, 180

Keshavarz, G., Thodi, P. and Khan, F. (2012). Risk-based shutdown management of lng units. *Journal of Loss Prevention in the Process Industries*, **25**, 159–165. 136

Kober, R., Ng, J. and Paul, B.J. (2007). The interrelationship between management control mechanisms and strategy. *Management Accounting Research*, **18**, 425–452. 56, 59, 60

Kochanowski, S., Seifert, C.F. and Yukl, G. (2010). Using coaching to enhance the effects of behavioral feedback to managers. *Journal of Leadership & Organizational Studies*, **17**, 363–369. 99

Kolodny, H. and Stjernberg, T. (1993). Self-managing teams: The new organization of work. *The Portable MBA in Management. NY: John Wiley & Sons*, 279–314. 159

Kotter, J.P. (1995). Leading change: Why transformation efforts fail. *Harvard business review*, **73**, 59–67. A-70

Kumar, U., Parida, A., Duffuaa, S.O., Söderholm, P. and Norrbin, P. (2013). Risk-based dependability approach to maintenance performance measurement. *Journal of Quality in Maintenance Engineering*, **19**, 316–329. 73

Kwak, Y.H. and Anbari, F.T. (2006). Benefits, obstacles, and future of six sigma approach. *Technovation*, **26**, 708–715. 74, 75

Laffan, B. (1983). Policy implementation in the european community: The european social fund as a case study*. *JCMS: Journal of Common Market Studies*, **21**, 389–408. 85, 86

Lai, J.H. (2013). An analysis of maintenance demand, manpower, and performance of hotel engineering facilities. *Journal of Hospitality & Tourism Research*, **37**, 426–444. 117

Langfield-Smith, K. (1997). Management control systems and strategy: a critical review. *Accounting, organizations and society*, **22**, 207–232. 53, 56, 162

Lawler, E. and Mohrman, S. (2000). Beyond the vision: What makes hr effective? *Human Resource Planning*, **23**, 10–20. 44

Lehner, J. (2004). Strategy implementation tactics as response to organizational, strategic, and environmental imperatives. *Management revue*, 460–480. 93, 98

Levitt, J. (2009). *The handbook of maintenance management*. Industrial Press Inc. 148

Li, H., Guihui, S. and Eppler, M. (2008). Making strategy work: A literature review on the factors influencing strategy implementation (rep. no. ica working paper 2/2008:). *Lugano, Switzerland: Institute of Corporate Communication*. 85, 86, 173

Liedtka, J.M. (2001). Strategy formulation: The roles of conversation and design. *Handbook of Strategic Management, Oxford, UK: Blackwell Publishers*, 70–93. 42, 43, 44, 233

Lippman, S.A. and Rumelt, R.P. (2003). A bargaining perspective on resource advantage. *Strategic Management Journal*, **24**, 1069–1086. 119

Løwendahl, B. and Revang, Ø. (1998). Challenges to existing strategy theory in a postindustrial society. *Strategic management journal*, **19**, 755–773. 47, 155

Malik, S. (2005). *Enterprise dashboards: design and best practices for IT*. John Wiley & Sons. 65

Mankins, M.C. and Steele, R. (2005). Turning great strategy into great performance. *Harvard Business Review*, **2607**. 3, 4, 82, 83, 87

Mankins, M.C. and Steele, R. (2006). Stop making plans; start making decisions. *Harvard business review*, **84**, 76. 87

Mansfield, R. (2013). *Company strategy and organizational design*. Routledge. 138

March, C. (2010). The five biggest risks to effective asset management. *Life Cycle Engineering*. 175

Marr, B., Schiuma, G. and Neely, A. (2004). The dynamics of value creation: mapping your intellectual performance drivers. *Journal of Intellectual Capital*, **5**, 312–325. 73, 74, 113, 114, 116, 120, 122

Marshall, G. (1994). Concise dictionary of sociology. *New York: Oxford University*. 45, 52, 93, 154

Martin, R.L. (2010). The execution trap. *Harvard Business Review*, **88**, 64. 92

May, C. (2013). *The Global Political Economy of Intellectual Property Rights: The New Enclosures?*, vol. 3. Routledge. 118

McCloskey, J.F. (1954). Training for operations research. *Journal of the Operations Research Society of America*, **2**, 386–392. 145

McCraw, T.K. (1997). *Creating modern capitalism: how entrepreneurs, companies, and countries triumphed in three industrial revolutions*. Harvard University Press. 25, 26, 143

McGrath, J.E. (1981). Dilemmatics: The study of research choices and dilemmas. *American Behavioral Scientist*, **25**, 179–210. 13, 14, 16

McIntyre, H.H. and Foti, R.J. (2013). The impact of shared leadership on teamwork mental models and performance in self-directed teams. *Group Processes & Intergroup Relations*, **16**, 46–57. 160

McKone, K.E. and Weiss, E.N. (2002). Guidelines for implementing predictive maintenance*. *Production and Operations Management*, **11**, 109–124. 136

McNett, W. (2015). Monitoring asset management strategy execution with kpis. *Life Cycle Engineering*. 175

McNulty, S. (2010). Transocean accused over deepwater maintenance. *Financial Times*. 182, 183

Mendis, S., Puska, P., Norrving, B. *et al.* (2011). *Global atlas on cardiovascular disease prevention and control.*. World Health Organization. 197, 205

Meyer, J.P. and Allen, N.J. (1991). A three-component conceptualization of organizational commitment. *Human resource management review*, **1**, 61–89. 96

Meyer, J.P., Stanley, D.J., Herscovitch, L. and Topolnytsky, L. (2002). Affective, continuance, and normative commitment to the organization: A meta-analysis of antecedents, correlates, and consequences. *Journal of vocational behavior*, **61**, 20–52. 96, 97

Michaud, R.O. and Michaud, R.O. (2008). Efficient asset management: a practical guide to stock portfolio optimization and asset allocation. *OUP Catalogue*. 112

Miller, S. (1997). Implementing strategic decisions: four key success factors. *Organization Studies*, **18**, 577–602. 3, 4, 82, 84, 86, 89, 172, 173, 200

Miller, S., Wilson, D. and Hickson, D. (2004). Beyond planning:: Strategies for successfully implementing strategic decisions. *Long Range Planning*, **37**, 201–218. 4, 9, 82, 83

Mintzberg, H. (1994). The fall and rise of strategic planning. *Harvard Business Review*, **January-February, Vol 72, No 1**, 107 – 114. 41, 44

Mischel, W. (1973). Toward a cognitive social learning reconceptualization of personality. *Psychological review*, **80**, 252. 93

Mitchell, J. and Carlson, J. (2001). Equipment asset management–what are the real requirements? *Reliability Magazine*, **4**, 14. 124, 172, 175

Mitchell, J.S., Hickman, J.E. and Amadi-Echendu, J.E. (2007). *Physical asset management handbook*. Clarion technical publishers. 5, 7, 122, 138, 158, 175, 177, 178, 179, 180

Moore, G.E. *et al.* (1965). Cramming more components onto integrated circuits. 64

Mosca, L., Jones, W.K., King, K.B., Ouyang, P., Redberg, R.F., Hill, M.N. *et al.* (2000). Awareness, perception, and knowledge of heart disease risk and prevention among women in the united states. *Archives of Family Medicine*, **9**, 506. 204, 212, 247, 281

Mosca, L., Ferris, A., Fabunmi, R. and Robertson, R.M. (2004). Tracking womens awareness of heart disease an american heart association national study. *Circulation*, **109**, 573–579. 204

Muchiri, P., Pintelon, L., Gelders, L. and Martin, H. (2011). Development of maintenance function performance measurement framework and indicators. *International Journal of Production Economics*, **131**, 295–302. 138

Mumby, D.K. and Putnam, L.L. (1992). The politics of emotion: A feminist reading of bounded rationality. *Academy of Management Review*, **17**, 465–486. 48, 157

Neely, A., Adams, C. and Kennerley, M. (2002). *The Performance Prism: The Scorecard for Measuring and Managing Business Success.*. FT Prentice Hall. 73

Neumann, L.J. and Morgenstern, O. (1947). *Theory of games and economic behavior*, vol. 60. Princeton university press Princeton, NJ. 28

Ngan, H.Y., Pang, G.K. and Yung, N.H. (2011). Automated fabric defect detectiona review. *Image and Vision Computing*, **29**, 442–458. 213

Noble, C.H. (1999a). Building the strategy implementation network. *Business Horizons*, **42**, 19–28. 101, 104, 105

Noble, C.H. (1999b). The eclectic roots of strategy implementation research. *Journal of business research*, **45**, 119–134. 82, 84, 85, 86, 95, 96, 97, 173

Noble, C.H. and Mokwa, M.P. (1999). Implementing marketing strategies: Developing and testing a managerial theory. *The Journal of Marketing*, 57–73. 97

Nonaka, I., Von Krogh, G. and Voelpel, S. (2006). Organizational knowledge creation theory: evolutionary paths and future advances. *Organization studies*, **27**, 1179–1208. 119

Nørreklit, H. (2003). The balanced scorecard: what is the score? a rhetorical analysis of the balanced scorecard. *Accounting, organizations and society*, **28**, 591–619. 72

Nutt, P.C. (1986). Tactics of implementation. *Academy of Management Journal*, **29**, 230–261. 98, 99, 180

Nutt, P.C. (1999). Surprising but true: Half the decisions in organizations fail. *The Academy of Management Executive*, **13**, 75–90. 3, 82, 87, 94, 98, 99, 180

Øien, K. (1998). Improved quality of input data for maintenance optimization using expert judgment. *Reliability Engineering & System Safety*, **60**, 93–101. 136

Otley, D. (1999). Performance management: a framework for management control systems research. *Management accounting research*, **10**, 363–382. 53, 54, 55, 56, 60, 73

PAS-55 (2004). 55-2. 2004. *Asset Management, Part 1: Guidelines for the Application of PAS 55*, **1**. 113, 114, 115, 116, 123, 124, 125, 134, 151, 178, 179

PAS-55 (2010). Pas-55. *British Standards Institute. xiv*. 127, 130, 134, 151, 152, 172, 178

Patel, V., Tandon, N. and Pandey, R. (2012). Defect detection in deep groove ball bearing in presence of external vibration using envelope analysis and duffing oscillator. *Measurement*, **45**, 960–970. 213

Pauwels, R.A., Buist, A.S., Calverley, P.M., Jenkins, C.R. and Hurd, S.S. (2014). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. *American journal of respiratory and critical care medicine*, **163**. 204

Peng, W. and Litteljohn, D. (2001). Organisational communication and strategy implementation-a primary inquiry. *International Journal of Contemporary Hospitality Management*, **13**, 360–363. 93

Peng, Y., Wang, G. and Wang, H. (2012). User preferences based software defect detection algorithms selection using mcdm. *Information Sciences*, **191**, 3–13. 213

Penrose, E.T. (1959). The theory of the growth of the firm. *Cambridge, MA*. 119, 147

Penrose, H.W. (2008). *Physical asset management for the executive*. Success by Design. 5

Peracchio, L.A., Bublitz, M.G. and Luna, D. (2014). Cultural diversity and marketing: The multicultural consumer. *The Oxford Handbook of Multicultural Identity*, 438. B-2

Percy, L. and Rossiter, J.R. (1992). A model of brand awareness and brand attitude advertising strategies. *Psychology & Marketing*, **9**, 263–274. B-1

Peters, T.J. and Waterman, R.H. (1982). In search of excellence: Lessons from americans best-run companies. *New York: Harper& Row*. 17, 41, 101, 162

Petrov, R.J. and Rowe, R.K. (1997). Geosynthetic clay liner (gcl)-chemical compatibility by hydraulic conductivity testing and factors impacting its performance. *Canadian Geotechnical Journal*, **34**, 863–885. 168

Pintelon, L. and Parodi-Herz, A. (2008). Maintenance: an evolutionary perspective. In *Complex system maintenance handbook*, 21–48, Springer. 6, 143, 144

Pintelon, L. and Van Puyvelde, F. (1997). Maintenance performance reporting systems: some experiences. *Journal of Quality in Maintenance Engineering*, **3**, 4–15. 138, 148

Ployhart, R.E. and Moliterno, T.P. (2011). Emergence of the human capital resource: A multilevel model. *Academy of Management Review*, **36**, 127–150. 119

Porter, M.E. (1980). Competitive strategies. *New York*. 32, 33, 34, 49

Porter, M.E. (1981). The contributions of industrial organization to strategic management. *Academy of management review*, **6**, 609–620. 147

Porter, M.E. and Millar, V.E. (1985). How information gives you competitive advantage. 40, 120

Porter, T.W. and Harper, S.C. (2003). Tactical implementation: the devil is in the details. *Business Horizons*, **46**, 53–60. 4, 83

Prahalad, C. and Hamel, G. (1993). The core competence of the corporation. *Organization of Transnational Corporations*, **11**, 359. 3, 39, 41, 120

Preuss, D. (2015). Eskom maintenance is not negotiable, says molefe. *Business Day*. 189

PWC (2012). Mine the growing disconnect. *Price Waterhouse Coopers Publication*. 175

PWC (2014). Closing the gap between strategy and execution. Tech. Rep., PWC. 87

QHA (2012). Asset management policy: Implementation standard for asset management. *Queensland Health Authority*. 175

Qi, H. (2005). Strategy implementation: the impact of demographic characteristics on the level of support received by middle managers. *MIR: Management International Review*, 45–70. 101

Raisinghani, M.S., Ette, H., Pierce, R., Cannon, G. and Daripaly, P. (2005). Six sigma: concepts, tools, and applications. *Industrial management & Data systems*, **105**, 491–505. 74

Rapert, M.I., Lynch, D. and Suter, T. (1996). Enhancing functional and organizational performance via strategic consensus and commitment. *Journal of Strategic Marketing*, **4**, 193–205. 93, 94

Rapert, M.I., Velliquette, A. and Garretson, J.A. (2002). The strategic implementation process: evoking strategic consensus through communication. *Journal of Business Research*, **55**, 301–310. 94, 95, 97, 179

Ries, A. (1992). The discipline of the narrow focus. *Journal of Business Strategy*, **13**, 3–9. 29

Robbins, S.P. and Coulter, M. (2007). Management. *Upper Saddle River*. 47

Rubin, H.J. and Rubin, I.S. (2011). *Qualitative interviewing: The art of hearing data*. Sage. 262, A-5

Ruefli, T. and Sarrazin, J. (1981). Strategic control of corporate development under ambiguous circumstances. *Management Science*, **27**, 1158–1170. 55

Sajdak, R., Trembath, L. and Thomas, K.S. (2013). The importance of standard operating procedures in clinical trials. *Journal of nuclear medicine technology*, **41**, 231–233. 119

Sashittal, H.C. and Wilemon, D. (1996). Marketing implementation in small and midsized industrial firms: An exploratory study. *Industrial Marketing Management*, **25**, 67–78. 98, 180

Schaap, J.I. (2012a). Toward strategy implementation success: An empirical study of the role of senior-level leaders in the nevada gaming industry. *UNLV Gaming Research & Review Journal*, **10**, 2. 93

Schaap, J.I. (2012b). Toward strategy implementation success: An empirical study of the role of senior-level leaders in the nevada gaming industry. *UNLV Gaming Research & Review Journal*, **10**, 2. 100

Schmidt, S.L. and Brauer, M. (2006). Strategic governance: How to assess board effectiveness in guiding strategy execution. *Corporate Governance: An International Review*, **14**, 13–22. 93

Schön, D.A. (1983). *The reflective practitioner: How professionals think in action*, vol. 5126. Basic books. 250

Schultz, T.W. (1993). The economic importance of human capital in modernization. *Education economics*, **1**, 13–19. 119

Schultz, T.W. and Schultz, T.W. (1982). *Investing in people: The economics of population quality*. Univ of California Press. 119

Schuman, C.A. and Brent, A.C. (2005). Asset life cycle management: towards improving physical asset performance in the process industry. *International Journal of Operations & Production Management*, **25**, 566–579. 123, 135, 175

Selznick, P. (1984). *Leadership in administration: A sociological interpretation*. Univ of California Press. 39, 120

Senge, P.M. (2014). *The fifth discipline fieldbook*. Random House LLC. 51, 52, 239, 240

Senge, P.M. and Suzuki, J. (1994). *The fifth discipline: The art and practice of the learning organization*. Currency Doubleday New York. 51, 240, 241

Shah, M. and Littlefield, M. (2009). Managing risks in asset intensive operations. *Aberdeen Group,(March, 2009)*. 139

Sherwin, D. (2000). A review of overall models for maintenance management. *Journal of quality in maintenance engineering*, **6**, 138–164. 142, 143, 147, 154, 161, 164

Shubik, M. (1987). *Game theory in the social sciences*. MIT press. 13

Simon, H.A. (1977). The logic of heuristic decision making. In *Models of discovery*, 154–175, Springer. 66, 131, 133, 162

Simons, R. (1987). Accounting control systems and business strategy: an empirical analysis. *Accounting, Organizations and Society*, **12**, 357–374. 72

Simons, R. (1991). Strategic orientation and top management attention to control systems. *Strategic Management Journal*, **12**, 49–62. 56, 57, 58

Simons, R. (1994). How new top managers use control systems as levers of strategic renewal. *Strategic management journal*, **15**, 169–189. 53, 56, 57, 60, 72

Simons, T. and Roberson, Q. (2003). Why managers should care about fairness: the effects of aggregate justice perceptions on organizational outcomes. *Journal of Applied Psychology*, **88**, 432. 4, 83

Sjöström, M., Karlsson, A., Kaati, G., Yngve, A., Green, L. and Bygren, L. (1999). A four week residential program for primary health care patients to control obesity and related heart risk factors: effective application of principles of learning and lifestyle change. *European journal of clinical nutrition*, **53**, S72–S77. 242, 243

Slater, S.E. (1989). The influence of managerial style on business unit performance. *Journal of Management*, **15**, 441–455. 93, 179

Slater, S.F. and Olson, E.M. (2001). Marketing's contribution to the implementation of business strategy: An empirical analysis. *Strategic Management Journal*, **22**, 1055–1067. 92

Snee, R.D. and Hoerl, R.W. (2003). *Leading Six Sigma: a step-by-step guide based on experience with GE and other Six Sigma companies*. Ft Press. 74

Stacey, R. (1991). *The choas frontier*. Butterworth-Heinemann. 41

Stanford, N. (2007). *Guide to organisation design: creating high-performing and adaptable enterprises*, vol. 10. John Wiley & Sons. 236, 237

Staubus, G.J. (1971). *Activity costing and input-output accounting*. RD Irwin Homewood, IL. 69

Stern, J.M., Stewart, G.B. and Chew, D.H. (1995). The eva® financial management system. *Journal of Applied Corporate Finance*, **8**, 32–46. 71

Stewart, D., Kennedy, B., Norton, L., Byrne, R. and Rose, D. (2003). Strategic asset management planning: How the orange county sanitation district adopted the team approach. *Water environment & technology*, **15**, 34–40. 158, 180

Stewart III, B. (1991). G.(1991)the quest for value . *New York*. 71

Sull, D. (2007). Closing the gap between strategy and execution. *Sloan Management Review*. 82, 101, 106, 107, 108, 109

Sull, D., Homkes, R. and Sull, C. (2015). Why strategy execution unravels and what to do about it. *Harvard Business Review*. 3, 4, 82, 87, 109

Tannenbaum, S.I., Mathieu, J.E., Salas, E. and Cohen, D. (2012). Teams are changing: Are research and practice evolving fast enough? *Industrial and Organizational Psychology*, **5**, 2–24. 160

Thomas, A., Barton, R. and Chuke-Okafor, C. (2008). Applying lean six sigma in a small engineering company-a model for change. *Journal of Manufacturing Technology Management*, **20**, 113–129. 164, 165, 166

Thurrow, L. (1996). The future of capitalism: How todays economic forces shape tomorrows world. *William Morrow and Company, Inc., New York, NY*. 40

Tolkien, J. (1937). *The Hobbit, or There and Back Again*. George Allen & Unwin. 233

Tsang, A.H. (1998). A strategic approach to managing maintenance performance. *Journal of Quality in Maintenance Engineering*, **4**, 87–94. 163, 164

Tsang, A.H. (2002). Strategic dimensions of maintenance management. *Journal of Quality in Maintenance Engineering*, **8**, 7–39. 5, 148, 150, 153, 155, 158, 159, 164, 180, 302

Tsang, A.H. (2009). *Maintenance performance management in capital intensive organizations: Key to optimizing management of physical infrastructure assets*. Lambert Academic Publishing. 117, 178

Turban, E., Sharda, R., Delen, D. and Efraim, T. (2007). *Decision support and business intelligence systems*. Pearson Education India. 65, 66, 67, 68, 69, 132, 133

U, D.K. (1999). New trends in aircraft reliability and maintenance measures. *Journal of Quality in Maintenance Engineering*, **5**, 287–295. A-99

Van Amelsvoort, P. and Benders, J. (1996). Team time: a model for developing self-directed work teams. *International Journal of operations & production Management*, **16**, 159–170. 160

Van den Honert, A., Schoeman, J. and Vlok, P.J. (2013). Correlating the content and context of pas 55 with the iso 55000 series. *South African Journal of Industrial Engineering*, **24**, 24–32. 125, A-98, A-99

van Veen-Dirks, P. and Wijn, M. (2002). Strategic control: meshing critical success factors with the balanced scorecard. *Long range planning*, **35**, 407–427. 56, 59, 60

Vancil, R.F. and Buddrus, L.E. (1979). *Decentralization: Managerial ambiguity by design*. Dow Jones-Irwin. 72

Von Bertalanffy, L. (1968). General systems theory. *New York: George Braziller*. 50, 51

Wacker, J.G. (1998). A definition of theory: research guidelines for different theory-building research methods in operations management. *Journal of operations management*, **16**, 361–385. 15

Walderseel, R. and Sheather, S. (1996). The effects of strategy type on strategy implementation actions. *Human Relations*, **49**, 105–122. 93, 94, 179

Weber, M. (2009). *From Max Weber: essays in sociology*. Routledge. 47, 155

Weick, K.E. (1995). *Sensemaking in organizations*, vol. 3. Sage. 4, 83

Wenzler, I. (2005). Development of an asset management strategy for a network utility company: Lessons from a dynamic business simulation approach. *Simulation & Gaming*, **36**, 75–90. 151

Widener, S.K. (2007). An empirical analysis of the levers of control framework. *Accounting, Organizations and Society*, **32**, 757–788. 58, 60

Willmott, P. (1994). *Total productive maintenance: The Western way*. Butterworth-Heinemann. 148

Wilson, A. (1999). Asset mgnt-asset management-and maintenance strategy-asset maintenance policies should offer various options in line with the plans for the future of the organisation two years or more ahead. a. *Maintenance and Asset Management*, **14**, 3–10. 148

Wilson, J.M.G. and Jungner, G. (1966). *The Principles and Practice of Screening for Disease*. World Health Organization. 212

Wolin, S. (1961). *Politics and Vision*. Allen and Unwin. 25

Womack, J.P. and Jones, D.T. (1996). Lean thinking: Banish waste and create wealth in your organisation. *Simon and Shuster, New York, NY*, **397**. 165

Woodhouse, J. (1997). What is asset management? *Maintenance and Asset Management*, **12**, 26–28. 111, 122, 175, 179

Woodhouse, J. (2006). Putting the total jigsaw puzzle together: Pas 55 standard for the integrated, optimized management of assets. In *International Maintenance Conference*. 178

Wooldridge, B. and Floyd, S.W. (1990). The strategy process, middle management involvement, and organizational performance. *Strategic Management Journal*, **11**, 231–241. 94, 179

Worley, C.G. and Lawler III, E.E. (2010). Agility and organization design:: A diagnostic framework. *Organizational Dynamics*, **39**, 194–204. 138, 157

Wuensch, K.L. (2005). What is a likert scale? and how do you pronounce'likert?'. *East Carolina University*. 140

Yang, B., Watkins, K.E. and Marsick, V.J. (2004). The construct of the learning organization: Dimensions, measurement, and validation. *Human Resource Development Quarterly*, **15**, 31–55. 52

Yang, L., Sun, G. and Eppler, M. (2009). Making strategy work: A literature review on the factors influencing strategy implementation. *Handbook of research on Strategy Process*, 165–181. 84, 87, 91, 93, 95, 98, 99, 100, 101, 176, 192, 311

Yergin, D. (2011). *The prize: The epic quest for oil, money & power*. Simon and Schuster. 31

Yin, R.K. (2013). *Case study research: Design and methods*. Sage publications. 15, 16, 251, 255, 313

Yun, Y.H., Lee, M.K., Kim, S.Y., Lee, W.J., Jung, K.H., Do, Y.R., Kim, S., Heo, D.S., Choi, J.S., Park, S.Y. *et al.* (2011). Impact of awareness of terminal illness and use of palliative care or intensive care unit on the survival of terminally ill patients with cancer: prospective cohort study. *Journal of Clinical Oncology*, **29**, 2474–2480. 204

Zheng, W., Yang, B. and McLean, G.N. (2010). Linking organizational culture, structure, strategy, and organizational effectiveness: Mediating role of knowledge management. *Journal of Business Research*, **63**, 763–771. 118

Zhou, X., Xi, L. and Lee, J. (2007). Reliability-centered predictive maintenance scheduling for a continuously monitored system subject to degradation. *Reliability Engineering & System Safety*, **92**, 530–534. 136

Appendix A

ABC Concentrator PAM assessment report

The following text is the unabridged observations of the PAM practices and processes and burning platforms, made during the assessment that took place prior to the operationalization of the PAMSEEM. It is however important to note the following:

- The structure and content of the report is exactly similar to the actual report presented to the steering committee. For the sake of uniformity the format of the report has however been adapted to conform to the format used in this document; and
- In accordance with the research agreement entered into between the University of Stellenbosch and the Concentrator the actual identities of the Business Unit as well as critical stakeholders will not be revealed – reference will only be made to ABC Concentrator. In addition hereto some of the less important facts and characteristics of this Concentrator was deliberately changed in an attempt to protect the identity of both the organizations and the stakeholders that formed part of this study.

A.1 Introduction and contextualization

The management of PA has been done for many years, but the scope of its management has undergone a significant shift in recent years. Amadi-Echendu (2004) refers to the *"Paradigm shift from maintenance to Physical Asset Management (PAM)"*. He is however of the opinion that is was only since the turn of the century that academics and practition-

ers illustrated growing interest in generalising PAM. The generalisation of acrshortpam also require the breakdown of organizational silo's. The contemporary perspective on PAM thus highlights the importance of a multidisciplinary skill set, cross functionality, and targets organizational synergies. The prevalent threats, from traditional paradigms, silo mentality and communication deficiency shifted towards an integrated view that especially emphasizes the strategic and human dimension.

The group Mining and Technology (M&T) function of the Anglo American Corporation (AAC), has developed an AM standard, theAnglo American Group Technical Standards 20 (AA GTS 20), targeting the production value chain, focusing on the management of a PAs over its complete life cycle.

The AA GTS 20 provides guidelines for Business Units (BU)s to add value through waste reduction, cost cutting, time saving and efficiency improvements. These activities span the entire business, and require benchmarking the performance of all assets and processes, from natural resources and capital to processes and skills.

In this report the project scope and agreed deliverables are presented in Section 2. In Section 3 the audit methodology used for the purpose of the project are explained. In Section 4 the most critical observations are discussed and in Section 5 a Recommendations Framework is presented. A detailed presentation of all observations is included as part of the Appendix A. Additional background to the Recommendations Framework is included in Appendix B.

A.2 The project scope and objectives

During June 2014 the task team approached Mr Thabo Lerabo (The Engineering Manager: ABC Concentrators). The purpose of the study was explained to him and he immediately expressed interest in assisting with the development and validation of the PAMSEEM. Mr Lerabo also accepted the importance of gaining and in-depth understanding of all PAM practices within the context of the ABC Concentrator.

In order to achieve this objective it was agreed that a PAM assessment, during which all aspects of the PAM practices and principles will be evaluated and burning platforms identified, had to be conducted prior to the operationalization of the PAMSEEM.

During the project scoping phase Mr Lerabo shared the following ABC Concentrator, Engineering Department vision and agreed to a number of project objectives.

A.2.1 The ABC Engineering Department vision

> *"To create an Engineering Organization that has the capacity to execute its PAM strategy effectively and consistently. An organization that has the built-in capacity to shift, flex, and adjust, either alone or with its internal as*

well as external partners as circumstances change, and to do so as a matter of course."

A.2.2 Audit objectives

The following key project objectives were identified:

- To assess the PAM functions and processes within the ABC Concentrator a BU within Anglo American Platinum (AAP);
- To identify possible PAM Strategy Execution risks and barriers; and
- To make recommendations regarding the removal of PAM risks and barriers.

A.2.3 The project team

It was agreed to make use of an external project team for the following reasons:

- An external task team is typically better positioned to create a non–threatening environment where employees can share their opinions and join in on the design, which also helps with obtaining their buy–in;
- The use of an external team is normally a more effective way of determining the change readiness. In those instances where seniors evaluate and assess process and practices (based on their experience) change readiness is normally not considered during the assessment process. This not only prolongs the process but also introduce other associated risks including the fact that all relevant stakeholders are not involved during the improvement process (no involvement typically results in no commitment);
- ABC Concentrator resources do not currently have the capacity to conduct the exercise in this manner; and
- It is acknowledged that an audit of this kind demands and deserves specialist knowledge.

In the next section the audit approach and methodology used for the purpose of the assignment will be discussed in more detail.

A.3 The Audit methodology

With a mandate to assess the PAM functions and processes within the ABC Concentrator, a decision was made to utilize triangulation of theory and methodology to increase the reliability of observation.

In the next sections the establishment of the assessment environment and the information gathering methodology, participants and boundary conditions are discussed in more detail.

A.3.1 Establishment of the assessment environment

The first step of any assessment of this kind requires the establishment of an environment that is conducive to assessment. During this process it was essential to define the project vision and objectives, secure leadership support, identify relevant stakeholders and define an information gathering methodology. The project teams approach to these aspects are briefly presented in the next section.

- **Vision**

  The project vision was formulated and is presented in Section A.2.1.

- **Objectives**

  The project objectives were formulated and are presented in Section A.2.2

- **Leadership support** A huge amount of effort was put into building leadership support, before the commencement of the actual information gathering process as well as during the assess phase. Although the project team did not encounter any notable negative feedback from participants during the assess phase, acceptance levels regarding the project and its objectives were not evaluated specifically.

- **Stakeholder analysis and engagement**

  Stakeholder analysis is an important change enabler. Stakeholder analysis was done in conjunction with Mr Lerabo. The stakeholders included as part of this project is presented in Section A.3.2.2.

  The Information gathering methodology and process are discussed in detail in Section A.3.2.

A.3.2 Information gathering methodology, participants and boundary conditions

In line with the principles of triangulation the project team was required to not only rely on information gathered during interviews and document evaluations but to physi-

cally observe engineering and operational practices and processes ("dirty boots"). The observations were made during all shifts including over the weekend.

The decision to use a qualitative methodology was based on the very nature of qualitative research, best described in terms of its interpretive and holistic approach. The main aim of the qualitative approach is to understand the social reality of the respondents and the meaning that people attach to it. The following features of the qualitative approach should be noted:

- Qualitative researchers discard the notion of an external, objective reality. They aim to understand reality by discovering the meanings that people in a specific setting attach to it. To them behaviour is intentional and creative, and it can be explained but not predicted;
- The qualitative researcher is subjective, interacts with the subject and accepts that s/he cannot be detached and value-free; and
- Qualitative methodology is dialectical and interpretive. During the process of interaction between the researcher and the subject, the subjects world is discovered and interpreted by means of qualitative methods.

A.3.2.1 The theoretical framework

The Interpretive Paradigm (IP) was selected as the dominant theoretical framework for this project. This framework was seen as most suitable for the purpose of the project. Rubin & Rubin (2011) contends that the IP requires the investigator to examine meanings that have been socially constructed. The IP recognizes that meaning emerges through interaction and is not standardized from place to place and person to person. The IP emphasizes the importance of understanding the overall text of a conversation and, more broadly, the importance of seeing meaning in context.

It is consequently accepted that values and views differ from place to place and group to group. This framework postulates that there is not one reality out there to be measured, objects and events are understood by different people differently, and those perceptions are the reality –or realities- that the researcher focuses on:

"Interpretive researchers try to elicit interviewees views of their worlds, their work, and the events they have experienced or observed. To reconstruct and understand the interviewees experiences and interpretations, interpretive researchers seek thick and rich descriptions of the cultural and topical arenas they are studying and try to develop an empathetic understanding of the world of others"

Rubin & Rubin (2011)

Within the context of the Interpretative Paradigm the project team made used the motivational interview technique. Motivational interviewing focuses on exploring and resolving ambivalence and centres on motivational processes within the individual that facilitate change. The method differs from more "coercive" or externally–driven methods for motivating change as it does not impose change, but rather supports change in a manner congruent with the person's own values and concerns. Motivational interviewing is thus a collaborative, person–centered form of guiding to elicit and strengthen motivation for change. Although the technique requires a non–directional and non–judgemental approach, themes around victories, communication, the optimistic future, support requirements,capacity and expansion were specifically explored.

In summary, according to the interpretative paradigm:

- Reality can be understood and interpreted but not predicted and controlled;
- Knowledge arises from observation and interpretation; and
- Data is collected and analyzed through observation and interviewing.

In addition to information gathered during the interview process the source material evaluated by the project team included but were not limited to the following:

- Plant layout and diagrams;
- Organizational structure;
- Strategy documents to gain a better understanding of the current vision and mission;
- Month end reports;
- A variety of Standard operating procedures (SOP's);
- Examples of Job Cards and compliance documentation;

A.3.2.2 Stakeholders

The following stakeholders were included as part of the project scope:

- The Concentrator manager;
- The Plant manager
- Engineering managers;
- Section engineers;

- Engineering Foreman;
- Artisans;
- Shift Leaders;
- Operators;
- Human Resources practitioners; and
- Process managers;

A.3.2.3 Data gathering themes

The following general themes were explored for the purpose of the assessment phase:

- Strategic Management;
- Asset Supply Chain Management;
- Contractor Management;
- Leadership, People and Organization;
- Safety and Sustainability Management;
- Asset Financial Management;
- Asset Life Cycle Management;
- Work Management;
- Facilities, Tools and Workshops;
- Asset Information Management;
- Asset Care;
- Shut Down Management;
- Condition Monitoring; and
- Asset Defect Elimination.

A.3.2.4 Data analysis

Inductive reasoning was followed in the qualitative analysis of the collected data. Attempts were made to discover key issues, recurrent issues, patterns and relationships through close scrutiny of the data. Data was analyzed and interpreted by means of inductive abstraction and generalisation. The Constant Comparative method of was used. Units of information were identified during the interviews, which served as the basis for defining categories. Thereafter, units applicable to each category are compared. Two kinds of categories develop in this way: those constructed by the researchers and those that emerged as categories by the respondents through their language and cultural covering terms. The process of constant comparison stimulates thought that leads to both descriptive and explanatory categories. The properties of each category are noted by careful scrutiny of all the notes made during the interviews by the project team. The project team then progresses from comparing units with other units classified in the same category, to comparing units with the properties that have been tentatively identified. This was followed by category integration, when relationships between categories become more evident and the category set becomes more coherent. At this point, a specific construction of the phenomenon begins to assume and the construction becomes delimited. As delimiting occurs, the original list of categories become reducible because of the improved articulation and integration. At the same time, categories become saturated and so well defined, that all further information is found to support the category.

A.3.2.5 Boundary conditions

The project was conducted within the confines of the following conditions:

- All observations made were tested through interviews and cross-referenced; and
- In line with the project scope all information was gathered during an inclusive process; and
- In addition to the inclusion of specific role-players the snowball sampling technique was used to identify operational participants to the study.

A.4 Prioritized observations

The detailed description of observations made during this audit can be found in Section A.7. The purpose of this Section is to provide an overview of the most critical observations made during the audit.

A.4.1 Asset management strategy

A number of generic AAP PAM strategy guidelines and documents were found and evaluated. No evidence of a clearly defined and ABC Concentrator specific PAM strategy could however be found. This finding was also cross referenced during interviews with all levels of stakeholders.

A.4.2 Organizational Design (OD)

The current OD does not optimally support the creation of a responsive and adaptable PAM function. Senior managers are often straddled between strategic and operational responsibilities and numerous studies have found that in those instances were managers are forced to get involved in operational issues they are normally unable to provide strategic direction.

In addition hereto strong evidence of a "us and them" culture and conflict could be found. This is not unique to the ABC Concentrator and this phenomenon is found in most organizations were service departments function on a centralized basis.

A.4.3 Staff Engagement

Staff members especially at lower levels seem to be generally disengaged and short term focused. Various stakeholders raised concerns regarding a lack of work ethic. This could be the result of the recent labour unrest in the area, uncertainty regarding possible change of ownership of the ABC Concentrator as well as the lack of clearly defined ABC Concentrator specific strategic objectives. It was not possible to evaluate these observations in detail but disengagement is a huge barrier to effective Strategy Execution.

In addition hereto communication is mostly formal and top down. There is a very strong focus on safety but very little focus on any other strategic themes.

In line with the observations regarding communication the managerial style in general seem to be top-down and non-participative.

A.4.4 Human Capital Readiness

There seems to a lack of technical as well as leadership skills especially at the first line and Foreman level. This state of affairs might be the result of a multiplicity of factors. A detailed analysis of the factors falls outside the scope of this study. Engineering competencies and capabilities are however very important drivers of short–term performance. Long term performance and value is created once the organization has the ability to easily adapt to changing circumstances. The primary value creating capabilities in this regard are thus the ability to change and learn.

A.4.5 Defect Elimination (DE)

Equipment inherently possess defects of numerous types. These defects can be as a result of errors made during design and manufacturing, or damaged incurred during the life span of the equipment. These defects have the potential to result in a range of equipment failures, ultimately causing unwanted events such as operational downtime and personnel injury. It becomes apparent then, that defects should be considered an important contributor to the failures encountered in Asset Maintenance Management systems. Equipment failures can be mitigated through the identification of defects and taking the appropriate steps to eliminate these defects. DE is a method of defect identification and elimination. It offers a systematic approach in which the root cause of a problem or failure is identified, and following a "bottom up" approach, a solution to the problem can be found.

No evidence of any DE strategy or action plan could be found during the audit. This observation was cross-referenced during interviews with various stakeholders.

A.4.6 Condition Monitoring (CM)

The most crude method for operating machines is to run them until they fail, and then to try and repair them in order to make them fit for further service. This method of operation can be very expensive in terms of lost output and machine destruction, and in addition can involve hazards to personnel. It is now well recognized that, particularly in the case of a large plant, it is more economical and operationally satisfactory to carry out regular maintenance. This involves the maintenance of the machine or its various components at regular intervals, to reduce the likelihood of failure during a time when the machine is required to be available for use.

Despite the fact that no CM strategy or policy document is in place within the ABC Concentrator context strong evidence of CM on most critical assets were found. CM is done in in–house and outsourced to various companies and is done both on-line through the SCADA system and offline using various instruments such as infra red cameras, infra red thermometers, accelerometers and oil samples. The on-line CM assesses the vibration of motors and plumber blocks, pressures and flows in pipes and cells, as well as the temperatures of important components.

Safspec prepares grease reports and AFS prepares Mill reports for the ABC Concentrator section. Quest performs ultrasonic testing on mills. Oil analysis reports, prepared by OMSA, generally take a week to arrive after inspection. Thermography is performed in-house on relevant components (such as motors) every morning by the Mechanical Foreman. Cooling water is checked by Improchem.

In addition to the absence of a clearly defined CM strategy or policy the audit team is however also concerned about the following observations:

- CM is often used as a "stand alone" maintenance concept;

- Frequently CM is simply used for failure prediction, little else is asked for or expected;
- CM seems to be driven from the bottom upward;

A.4.7 Work Management

The design and implementation of a Work Management (WM) system is an essential element to the efficient utilization of resources and systems in the management of maintenance activities. It is a key component of the control mechanisms portfolio available to maintenance management.

Knowledge transfer lies at the heart of WM. This is accomplished by building new maintenance plans (the most knowledgeable way of doing the task), and sometimes recompiling existing plans (to avoid costly mistakes made in the past). However, the branches of WM extent even further, and can be summarized as follows:

"Well planned, properly scheduled, and effectively coordinated tasks accomplished more work, more efficiently, and at a lower cost. Work properly prepared in this fashion disturbs operations less frequently, and is accomplished with higher quality, greater task satisfaction, and higher organizational morale than tasks performed without proper preparation."

The application of WM makes dramatic improvement possible in maintenance productivity. It plays a critical role in assuring the optimum use of an enterprise's productive capacity. WM must be at the core of the any maintenance effort. It provides for reliable delivery of all the other proactive programmes.

The following specific observations regarding WM has been made:

- **Documentation** – The documentation process that needs to be followed before any job/task can be done on the plant is tedious and time-consuming;
- **Follow through and Feedback** – There seem to be very limited follow through and feedback after the completion of tasks. Artisans are often both executor and inspector. In addition hereto problem identifiers seldom if ever receive feedback when problems are solved;
- **Communication** – Ineffective communication has already been mentioned. It has been observed that there is a serious gap in communication between Engineering and Production that often results in blame shifting;
- **Planning** – The overall contention is that planning is ineffective. This reality has a significant impact on the total PAM function and should be addressed as a matter of urgency;

- **Call–out Management and Overtime** – Stakeholders were concerned that the management of call-outs and overtime is not effective. The ineffectiveness of this process was cross referenced and observed during a number of back-shifts.

A.4.8 Asset Financial Management

Managing business performance in today's complex and rapidly changing business climate is crucial for any organization's short-term and long-term success. In order to maintain investor confidence and provide insight to top management, there is an increased demand for finance organizations to provide prospective insights on business trends and drivers of performance. Financial planning, a key component of managing and driving business performance, continues to be of limited value and mired with conservatism for many organizations. Extended financial planning and forecasting cycle times that delay decision making, financial drivers and metrics that don't align with strategies and the ownership of planning projections adds to the frustration of numerous functions. This also includes disruption to many planning and forecasting activities.

Dissatisfaction with financial planning often echoes across the organization from executives who can't trust the accuracy and outputs from the process to the front line managers who question the amount of time spent on activities supporting the analysis, making it imperative for finance to reassess and transform the value of the overall financial planning process.

The following specific observations regarding asset finance management were made:

- **Granularity of budgets and cost reports** – The lowest common denominator on all cost reports are currently Cost Centres. This is the result of way in which SAP has been configured. This set-up makes it virtually impossible to hold Foremen accountable for cost control since the responsibilities of formen often overlap numerous sections or are limited to only parts of a particular section;

- **Asset categorization** – No evidence could be found of any asset categorization table or methodology. The implication is that decision makers are struggling to decide which assets and spares are more or less critical; and

- **Cost-benefit analysis** – No evidence of a clearly defined protocol regarding costs-benefit analysis could be found. Stakeholders indicated that they often find it difficult get assistance when cost-benefit trades-off need to be made and were these frustrated by slow responses when requests for cost-benefit evaluations are made.

- **Zero value balance sheet assets** - A large number of physical assets are acquired through the operational budget. The acquisition of these assets are thus typically regarded as an operational expense. The implication of this reality is many fold. The first of these is the fact that these assets are not registered on the organizational balance sheet. The non-registration of these assets on the balance sheet however

also has severe implication for Asset Life Cycle Management. These implications and recommendations are discussed in more detail in Section A.7 and Section A.8.

A.4.9 Asset Management Life Cycle (AMLC)

AMLC looks at the entire life span of an asset from inception to disposal. It takes a more holistic approach at estimating an assets costs and life. Even though an asset may only be used for a certain period of time, its development and decommissioning periods could be equally long.

Through a detailed understanding of an asset's, and in fact a system's, life cycle one should be able to maximize all potential benefits. Furthermore, the idea that asset's costs end after purchase needs to be eliminated, allowing the full cost of impact of assets to be realized through AMLC. AMLC also aids in the continuous improvement strategy. Where regular assessments are used to determine potential opportunities for performance improvements as well as identifying degrading performance. It then schedules and prepares the organization for the fact that an asset or system may be improved during its life cycle. This is in contrast to the run to failure strategy, or implement and forget. Lastly, AMLC is not a singular strategy, it employs practices from almost all the other Asset Maintenance Management practices. Only by working together can the full benefits of AMLC be realised. Therefore, one should always think about practices one can apply during the different stages of an asset's or system's life.

After numerous formal and informal conversations and interviews with engineering Foreman, Artisans and Planners, it was concluded that no AMLC policy or practices are currently in place within the ABC Concentrator context. Not only are the life cycles of assets not managed with any specific policy or long term vision, in staff were all unaware of the existence of AMLC.

Replace or repair decisions are made with a narrow-minded view on cost saving. Evidence was found of assets performing well below their rated performance level, that were kept in operation to postpone any future capital outlay. The long term cost of asset inefficiency is seemingly not really a consideration.

A.4.10 Shutdown management

One of the most resource intensive activities a company can undertake is planning and executing a scheduled plant Shutdown. A Shutdown is done to complete maintenance work that is difficult or impossible to perform while plant equipment is operational. Every industrial plant encounters several Shutdowns during its lifetime, be it for scheduled maintenance, replacement of parts, modification or expansion. The overriding challenge is to adhere to the most stringent safety standards and keep downtime to a minimum. To achieve that goal, the whole of logistical processes, which is comprised of the lifting, transport, installation and removal of many components, plays an important and

interdependent role.

Adding to Shutdown complexity is the fact that in such projects, multiple parties are generally working simultaneously at the same site. Given the number of tasks and associated resources involved, and the complexity of their interactions, it is necessary to appropriately manage the planning, execution and handover processes. All processes need to be repeatable, sustainable, and continuously improved. There are considerable challenges to making the systems and procedures for major Shutdowns simple and effective.

The ABC Concentrator is Shutdown for 48 hours every month to do general maintenance and repairs. None of the participants in this assessment were however able to explain why a monthly or four weekly Shutdown period was required. In addition hereto there is seemingly no long–term Shutdown plan and Shutdowns are thus planned on a case by case basis. Participants furthermore expressed concern about the effectiveness of Shutdown management in general. These concerns are validated by the fact that the plant is seldom fully operational within the planned Shutdown period.

A.5 The Recommendations Framework

The purpose of this section is to present a prioritized and summarized recommendations framework. This framework is discussed in more detail in Section A.8. We are of the opinion that the implementation of this framework would make a significant contribution in the quest to achieve the ABC Concentrator PAM vision.

The recommendations framework is presented in Figure A.8, and consists of four major elements:

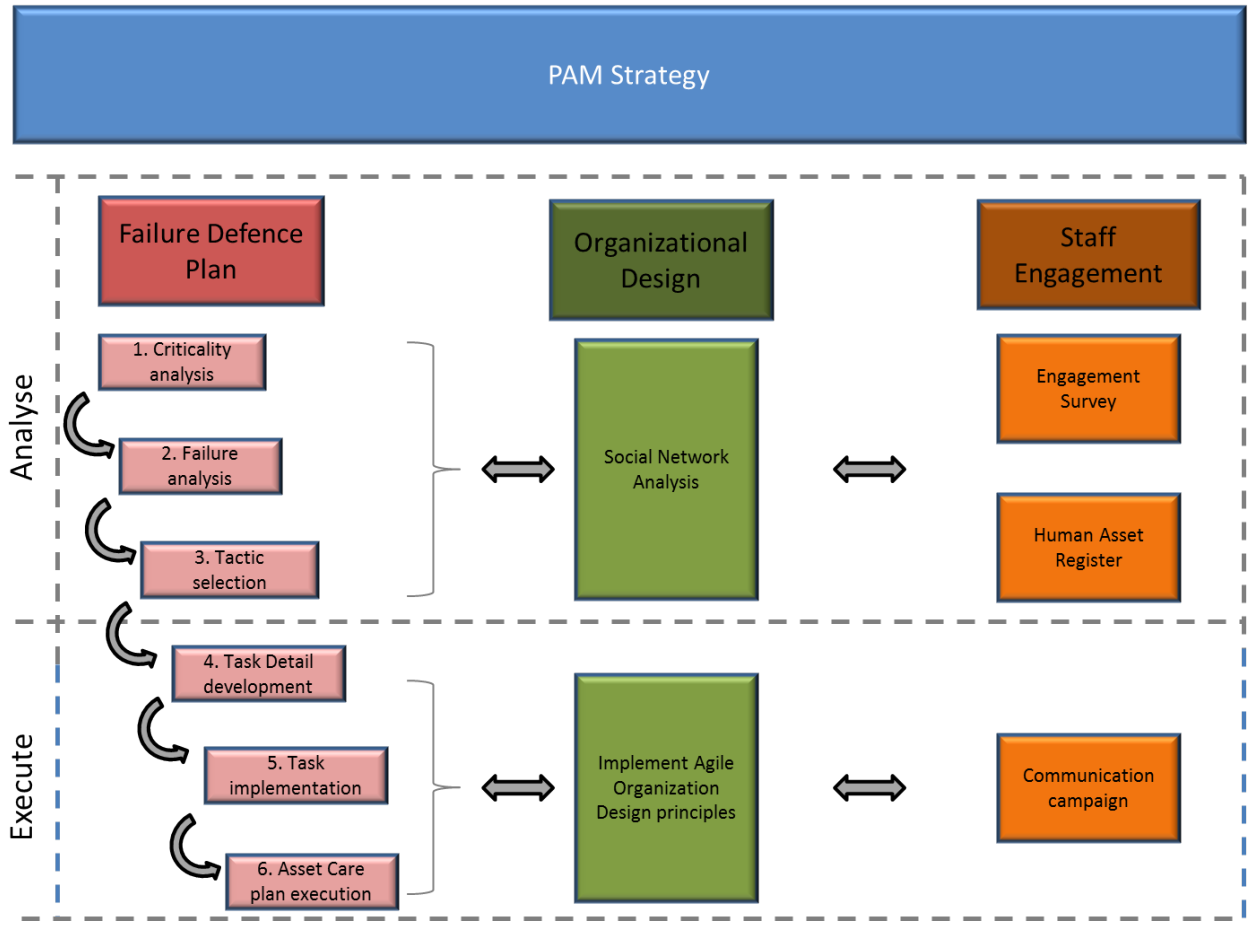
- The development of a PAM Strategy;
- The development of a PAM Failure Defence Plan;
- OD optimization; and
- Staff Engagement.

It is important to take cognisance of the fact that these elements are all interdependent and apart from the development of the PAM strategy that supersedes all other elements, these elements should be implemented in parallel. In the next section each of these elements are discussed and in more detail.

A.5.1 The development of a PAM strategy

AM Strategy is a long-term optimized approach to the management of assets, derived from, and consistent with, the organizational strategic plan and the AM policy. Fur-

Figure A.1: ABC PAM optimization recommendation framework



thermore, the Asset Management Strategy converts the objectives of the organizational strategic plan and the Asset Management policy into a high-level, long-term action plan for: the assets and/or asset system(s), the asset portfolios and/or the Asset Management System.

These high-level, long-term action plans for the assets and the asset management objectives are normally the outputs of the AM Strategy. These elements together form the basis for developing more specific and detailed AM plans.

The project team strongly recommends that the ABC Concentrator management team should develop an operation specific PAM strategy as a point of departure. The strategy should be clearly aligned to ABC Concentrator business strategy. The strategy development process should be as inclusive as possible and the observations and recommendations made in this study could be used as input during the definition process. In the absence of a clearly defined and communicated strategy and objectives it would be virtually impossible to achieve the ABC Concentrator PAM Vision as set out in Section A.2.1.

A.5.2 The development of a Failure Defence Plan (FDP)

The FDP consists of six sub-elements:

1. Criticality analysis;
2. Failure analysis;
3. Tactic Selection;
4. Task Detail Development;
5. Task Implementation; and
6. Asset Care Plan Execution.

Elements one to four mainly involves analysis, while elements five to seven requires and execution focus.

A.5.2.1 Criticality Analysis (CA)

In line with the PAM strategy the PAM team should identify the most critical AM opportunities and risks. It is extremely important to note that the CA is an inclusive process and that representatives from all relevant departments should as far as possible be involved during this phase.

A.5.2.2 Failure Analysis (FA)

After the identification of the most critical assets (normally the top 15%), the organization should initiate the FA phase. FA involves a formal procedure of determining the failure modes, effects and criticality of failures.

During the FA phase the following steps are typically followed:

- Analysis of all the potential failure modes of the various parts of a system;
- Analysis of the effect these failures may have on the system; and
- Identification of methods to avoid the failures, and/or to mitigate the effects of the failures on the system.

The following questions are typically asked to determine credible failure modes and their associated consequences:

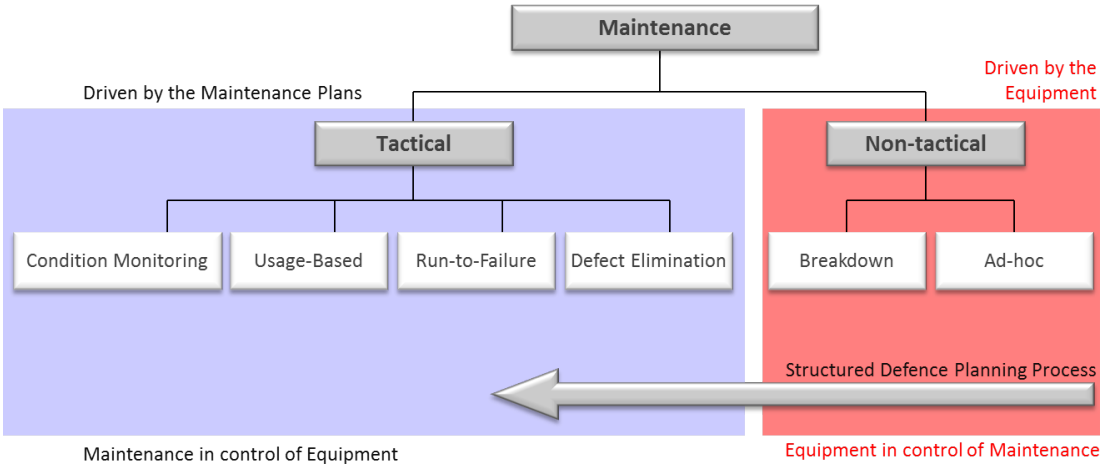
- How can each part conceivably fail?
- What mechanics might produce these modes of failure?
- What could the effects be if the failure did occur?
- Is the failure in the safe or unsafe direction?
- How is the failure detected?
- What inherent provisions are provided in the design to compensate for the failure?

FA is a comprehensive process designed to identify potential significant and credible failure modes associated with equipment or systems being assessed. The failure mode describes how a system may fail and includes all possible causes ranging from operator errors, deficient management systems or strategies. The frequencies, as well as potential production downtimes or cost effects, associated with each of the identified failure modes are recorded. Furthermore, the likelihood of detecting these failure modes prior to actual failure are also documented.

A.5.2.3 Tactic Selection

Once the FA phase has been completed the PAM team should select a maintenance tactic for each an every one of the critical assets. Figure A.9 illustrates the continuum of maintenance tactics. It is strongly recommended that the organization should not choose the tactics on the far right of the continuum. Equipment as opposed to the asset management team is in control when these tactics are chosen.

Figure A.2: Maintenance tactic continuum

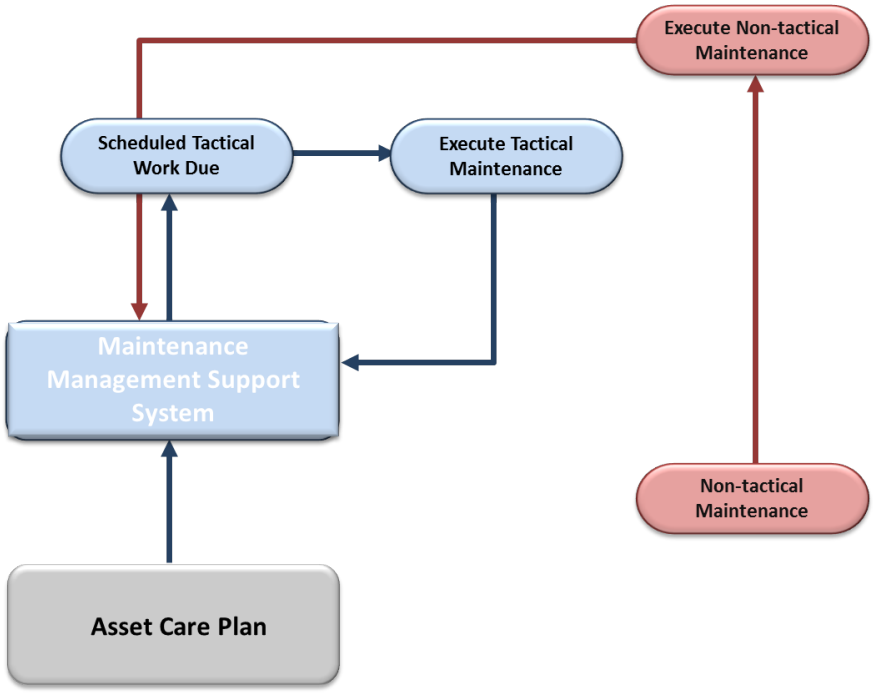


Irrespective of the outcome of the CA and FA the project team is of the opinion that the PAM team should consider the following action steps regarding Defect Elimination and Condition Monitoring:

- Develop a ABC Concentrator specific DE action plan;
- In the event the management team considers the formation of Centres of Excellence (CoE) (see Section A.8.3) DE could become a typical CoE. In line with the CoE operating principles of the team would typically be tasked with the identification of DE opportunities, these opportunities would be prioritized and systematically addressed.
- Develop a ABC Concentrator specific CM strategy and policy that is supported and aligned to the DE strategy;
- Key to this strategy is the development of a condition based maintenance programme that aids in the maintenance response to degrading conditions, not just a time based and intrusive programme that could well introduce degraded conditions by "fixing what is not broken"; and
- In the event the management team considers the formation of CoEs (see Section A.4.2) CM could become a typical CoE;
- Instil an organizational culture that is characterised by staff that understands the importance of PA conditioning.

In line with the Recommendation Framework it is important to during this phase take cognisance of both the Organizational Design as well as the availability of skills (Human

Figure A.3: Task Implementation and Control: Survival Mode



Asset Register). Choosing a specific maintenance tactic in the absence of relevant skills or if the organization design will not support the execution of such a tactic will be futile and will lead to failure and frustration.

A.5.2.4 Task Detail Development

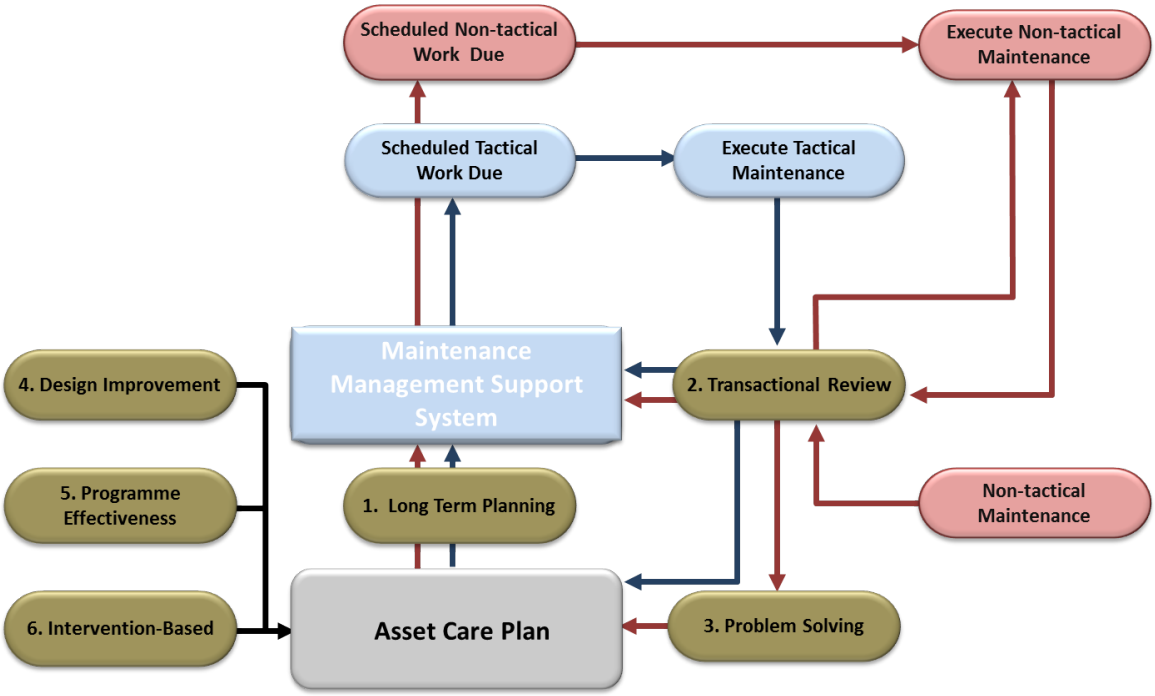
After selection of a relevant maintenance tactic the PAM team should develop a detailed plan to ensure effective implementation of the maintenance tactic. During this phase responsibility should be assigned to specific stakeholders and the terms of engagement (including relevant control mechanism) should be clearly established and communicated.

A.5.2.5 Task Implementation

Figure A.13 illustrates the Task Implementation process followed by immature organizations or organizations that finds themselves in asset management survival mode.

Figure A.14 however illustrates an optimized Task implementation process. Every effort should be made to ensure that the organization adopts this model as a matter of course.

Figure A.4: Task Implementation and Control: Optimization Mode



A.5.3 Organizational Design Optimization

In order to optimize the current organization design the following recommendations are made:

- Evaluate the communication and network dynamics between the operational and engineering teams in far more detail. This could be done through a Social Network Analysis (SNA). A detailed discussion of this recommendations falls outside the scope of this report; and
- Investigate the implementation of Agile organization design principles including the establishment of CoEs and multi-disciplinary SWAT teams. Practically this could imply that the current Engineering management becomes responsible for the establishment of PAM strategy and standards through the CoEs , while the Plant Manager through the Section Engineers are responsible for the execution of the strategy. A detailed discussion of this recommendation falls outside the scope of this report.

A.5.4 Staff Engagement

Staff Engagement is an extremely complex construct and it is important to note that there are no quick fixes. In the light of our understanding of the ABC Concentrator context the research team are of the opinion that the following possible interventions might assist management to improve the current status quo. Recommendations one and two mainly involves analysis while element three requires a focus on execution.

A.5.4.1 Staff Engagement survey

- Conduct a detailed engagement survey to define the real nature and extent of staff engagement;

A.5.4.2 Development of an agile Human Asset Base

Addressing the skills gap and experience shortage is a very complex process and requires an integrated approach and involvement by all stakeholders. In order to develop and agile Engineering Human Asset base it is strongly recommended that the organization:

- Develop an engineering competency matrix (Statement of Need (SoN));
- Develop a Human Asset Register (HAR) (Statement of Capability (SoC));
- Compile a competency gap analysis to determine the exact nature and extent of misalignment between the SoN and SoC; and
- Compile a skills development plan aimed at development of an agile Engineering Human Asset base.

These concepts in discussed in far more detail in Section A.8.

A.5.4.3 Communication Campaign

- Develop a strategically aligned communication campaign aimed at addressing the expectations and fears of staff members. The campaign should take cognisance of both stakeholder needs, content and communication media. The campaign should typically be preceded with some form of Social Network Analysis (SNA) (see above) to understand the real communication dynamics within the organization in more detail.

A.5.4.4 Management style

As indicated in Section A.7 relatively strong evidence of a top-down and non-participative management style was observed. This is particularly concerning especially if the advantages of a more participate management style is considered. The advantages of such a management style is well documented and include:

- **Increase in productivity** – An increased say in decision making means that there is a strong feeling of association. The employee now assumes responsibility and takes charges. Working hours for example may get stretched on their own without any compulsion or force from the management. All this leads to increased productivity;
- **Increased job jatisfaction** – In organizations that employ participative management, most of the employees are satisfied with their jobs and the level of satisfaction is very high. This is especially true when people see their suggestions and recommendations being implemented or put to practice. Psychologically, this tells the individual employee that, he or she too has a say in decision making and that he or she is an integral component of the organization and not a mere worker;
- **Motivation** – Increased productivity and job satisfaction cannot exist unless there is a high level of motivation in the employee. The contrary is however also true. Decentralized decision making means that everyone has a say and everyone is important;
- **Improved quality** – Since the inputs or feedback comes from people who are part of the processes at the lowest or execution level. This means that even the minutest details are taken care of and reported. No flaw or loophole goes unreported. Quality control thus begins and is ensured at the lowest level.
- **Reduced costs** – There is a lesser need of supervision and more emphasis is laid on widening of skills, self management. This and quality control means that the costs are controlled automatically.

It is however important to also caution against the fact that it the following disadvantages of the participative management style:

- **Decision making slows down** – Participative management stands for increased participation and when there are many people involved in decision making, the process definitely slows down. Inputs and feedback starts pouring from each side. It takes time to verify the accuracy of measurements which means that decision making will be slowed down; and
- **Abdication of responsibility** – Participative management can sometimes (especially in less mature environment) be interpreted as the abdication of responsibility.

In the light of the overwhelming advantages of the particular management style it is however strongly recommended that the style is cultivated as part of ongoing leadership development within the organization.

A.6 Conclusion

The Engineering Manager: ABC Concentrators – Mr. Thabo Lerabo requested the Project team to conduct a Plant AM assessment and assessment of the Engineering function of the ABC Concentrator. After careful scoping the project team embarked on a journey to achieve three major objectives:

- To assess the PAM functions and processes within the ABC Concentrator of AAP ABC Concentrator;
- To identify possible PAM Strategy Execution risks and barriers; and
- To make recommendations regarding the removal of PAM risks and barriers.

The project team is of the opinion that these objectives have been met and would like to thank all participants for the open and honest contributions. These contributions will be referred to during the operationalization of the PAMSEEM.

A.7 Detail Observations and Findings

A.7.1 Asset Management Strategy (AMST)

A number of generic Anglo American Platinum, Physical Asset Management Strategy (PAMS) guidelines and documents were found and evaluated. During the evaluation of these documents it was however revealed that no ABC Concentrator specific PAMS have been defined. This finding was also cross referenced during interviews with all levels of stakeholders. Stakeholders acknowledged this shortcoming and indicated that pressure was indeed exerted on them by corporate executives within AAP to develop a ABC specific PAM strategy. These stakeholders however expressed frustration with the complex nature of existing corporate PAM strategy documentation and guidlines.

The following quotes confirm this observation.

> *"...the pressure to develop a PAM strategy comes right from the top and every time John Peters, [the consultant][1], talks to me he wants to know how far we are with the strategy..."*

[1]Within the context of the AAP Corporations a number of corporate executives are appointed in specialist roles and are commonly referred to as "consultants" by stakeholders at the various operations.

Thabo Lerabo: Engineering manager

These stakeholders however expressed frustration with the complex nature of existing corporate PAM strategy documentation and guidelines.

> *"...I understand how important the a PAMS strategy is, but I think they [corporate executives] make it far too complex...they sit in their ivory towers and force things down on us..."*

Peter Hlare: Concentrator manager

> *"...look at this diagram it is impossible to explain this to a boilermaker..."*

Senior planner tasked with strategy development.

A.7.2 Organizational Design (OD)

The current OD does not optimally support the creation of a responsive and adaptable PAM function. Senior managers are often straddled between strategic and operational responsibilities and numerous studies have found that in those instances were managers are forced to get involved in operational issues they are normally unable to provide strategic direction.

In addition hereto strong evidence of a "us and them" culture and conflict could be found. This is not unique to the ABC Concentrator and this phenomenon is found in most organizations were service departments function on a centralised basis and teams are organized along functional lines.

> *"...if someone from production sees a problem that he/she believes is electrical and fills a job card for the electrical Foreman and the electrical artisan finds that the problem is actually for another department, the job gets left without any follow up..."*

Phillip van Zyl: Electrical Foreman

The design thus does not foster a sense of joint ownership. This is not unique to the ABC Concentrator and this phenomenon is found in most organizations were service departments function on a centralised basis.

Senior managers are often straddled between strategic and operational responsibilities and in those instances were managers were forced to get involved in operational issues they were normally unable to provide strategic direction.

"...the Section engineers are very young and inexperienced and I often get bogged down with operational issues...the Fast Track[1] *programme really does not help..."*

Thabo Lerabo: Engineering manager

A.7.3 Staff Engagement

Staff members especially at lower levels seem to be generally disengaged and short term focused. Various stakeholders raised concerns regarding a lack of work ethic. This could be the result of:

- The recent labour unrest in the area:

  "...the things that happened on the Koppie is affecting as badly ... the people don't trust management..."

  Mason Lube: Electical artisan

- The eminent change of ownership of the ABC Concentrator:

  "...the guys are no longer proud of their work, we don't know for how long we will still be around..."

  Sunnyboy Mlangu: Foreman electrical

- The lack of clearly defined ABC specific strategic objectives:

  "...Thabo has been in that position for 6 months now, he has not spoken to me once ... I do not understand what his plans are..."

  Stephen Johnson: Forman boilermaking

It was not possible to evaluate these observations in detail but disengagement is a huge barrier to effective strategy execution.

[1]The Fast Track programme is focused on the accelerated development and promotion of high potential individuals from previously disadvantaged communities. The programme is controversial and both black and white stakeholders have expressed their frustrations with the programme and its results.

A.7.4 Communication and management style

During the assessment of the characteristics and effectiveness of the communication process, the existing communication methods and communication media, as well as the content[1] The most pertinent observations regarding communication is presented in Table A.1.

Table A.1: ABC Concentrator communication characteristics

Communication method	**Purpose and typical content**	**Level of participation**
Daily workshop meeting	Feedback regarding the maintenance jobs that were completed the previous day and planning regarding jobs that are planned for the day ahead.	Mostly top-down.
Daily joint planning meeting	Representatives from both the Engineering and the Operations departments are present during this meeting. The purpose is to identify critical maintenance problems, but more importantly to plan for preventative maintenance operations. This meeting is often characterized by conflict and blame-shifting, and the focus is generally re-active.	Despite the fact that the meeting is on any day attended by no less than 10 – 15 representatives, very few stakeholders actively participate.
Monthly engineering meeeting	The purpose of this meeting is to provide feedback to the engineering team on organizational performance and projects planned for the month ahead.	This is a typical "town hall" style meeting with very little to not participation from attendees.
Notice boards	The purpose of notice board communication is unclear and most communication on notice boards are extremely dated and mostly irrelevant.	
E-mail	E-mails are mostly used to share operational information and to provide feedback on progress.	Only staff from Foreman level upwards have access to E-mail communication.

From the above presentation it should be clear that there is very little focus on any strategic content during formal communication. During in-depth interviews with a number of key stakeholders this observation was cross referenced and confirmed.

> *"...there is a lot of crises management around here... we do not often get the chance to sit back and plan for the future..."*
>
> Alfred Ngeni: Section Engineer

[1]It is important to note that there is an extremely strong focus on safety and the topic of safety permeates all formal communication.

I suppose he (Thabo Lerabo) is still finding his feet but he has never shared his strategy or vision with me... they only fight fires..."

John McDonald: Section Engineer

In line with the observations regarding communication the managerial style in general seem to be top-down and non-participative.

A.7.5 Human Capital Readiness

There seems to a lack of technical as well as leadership skills especially at the first line and Foreman level. This state of affairs might be the result of a multiplicity of factors including the ineffective deployment of the Fast Track programme as well as the general shortage of well qualified technical staff.

"... the Artisans were promoted to the Foremen position too prematurely. He feels that there are skills in the market that they arent tapping into. They have developed training matrices for Artisans and Foremen, however it will take a while to take effect..."

Siyabe Mabule: Boilermaker Foreman

A detailed analysis of the factors falls outside the scope of this study. Engineering competencies and capabilities are however very important drivers of short–term performance. Long term performance and value is created once the organization has the ability to easily adapt to changing circumstances. The primary value creating capabilities in this regard are this the ability to change and learn.

A.7.6 Inter-departmental Relations

The relationship between the members of the executive team seem to be sound. Since his appointment in October 2013, Peter Hlare focused very strongly on breaking down the silos that existed between Engineering and Plant staff. Both Thabo Lerabo the Engineering manager and Piet Lerabo the Plant manager were appointed after October 2013 and also seem to be committed to break down old barriers.

At the operational level strong evidence of a "us and them" culture was however still found. Plant supervisors and operators expressed huge frustration with the quality and level of service they received from the Engineering department.

"...these guys have no pride...they fix the same thing over and over..."

Joe Mblumbu: Plant Operator (Wet section)

The problem seem to be exacerbated during back shifts and over weekends when no engineering staff are at the plant.

> *"...we need to first go through all the channels to get a call-out approved only to be told by the electrician (when he eventually arrives) that he can only fix the problem if a Fitter assists him...by then we have lost the production for the total shift..."*

Johnson Themba: Plant Night Shift Supervisor

> *"...in the past they used to have "charge hands" ...these guys were able to fix everything – especially during night shift...*

Peter Bulela: Plant Night Supervisor

Engineering supervisors and operators however also expressed frustration. Especially at the fact the Plant supervisors and operators seem to take no ownership of the maintenance of equipment.

> *"...these guys have been working here for many years, they can hear a when a pump is makes funny noises... why do they wait until it breaks?"*

Mauritz Minnaar: Fitter

> *"...they walk past this conveyer belt three of four time a day ... did they not see the tear...these guys really don't care...it far easier just to wait until it breaks..."*

Syia Ngapi: Fitter

The daily Joint Planning Meeting (referred to in Table A.1) was an initiated by Thabo Lerabo and Piet Lerabo to address some of these relationship issues. These meetings are however also characterized by conflict and the leadership team should investigate more ways to improve inter-departmental working relations.

A.7.7 Defect Elimination (DE)

Equipment inherently possess defects of numerous types. These defects can be as a result of errors made during design and manufacturing, or damaged incurred during the life span of the equipment. These defects have the potential to result in a range of equipment failures, ultimately causing unwanted events such as operational downtime and personnel injury. It becomes apparent then, that defects should be considered an important contributor to the failures encountered in Asset Maintenance Management systems. Equipment failures can be mitigated through the identification of defects and taking the appropriate steps to eliminate these defects. DE is a method of defect identification and elimination. It offers a systematic approach in which the root cause of a problem or failure is identified, and following a "bottom up" approach, a solution to the problem can be found.

No evidence of any DE strategy or action plan could be found during the audit. This observation was cross-referenced during interviews with various stakeholders.

Walking the plant has shown many small areas that could be improved upon in order to avoid bigger problems and incidents. The following observations were made, where defect elimination could possibly be implemented. These include;

- Water spillages and leaks all over the plant

The water spillages and the stagnant water on the shop floor all over the plant is hazardous in terms of water coming into contact with motors and electrical wires and also compromises the safety for the workers. This water could also contribute to the rusting of equipment and infrastructure.

- Scrap lying around

This is a safety hazard and has in fact already contributed to an incident on the plant that resulted in an injury.

- Cooling systems in the control and instrumentation rooms

These control systems build up a lot of heat and will overheat if the air conditioners or fans are not in working order. It is recommended that these systems are serviced and inspected regularly.

- Corrosion of structures

The infrastructure and many pieces of equipment around the plant are corroded. It is suggested that structural maintenance should be done for corrosion protection as the structure is clearly deteriorating.

- Beams/Wires across walkways

This is a safety hazard for workers as it could lead to tripping and falling.

- Replacement of old corroded pipes

The valuable material gets spilled and lost in the secondary scavengers due to old and corroded pipes. This loss in production and quality can be avoided by replacing the old pipes with plastic ones to avoid the rust.

- Replacement of rubber cylinders

It is suspected that the rubber cylinders are too worn down and putting too much pressure on the beams under the vibrating screens causing them to snap. This is happening too often and could be avoided completely with defect elimination.

- Water Drainage

The water from the pebble beds is just running onto the road and over the walkways, which is a concern in terms of safety and water wastage. It is recommended that a drainage system or some sort of water recovery system is implemented.

- Overflowing pebble box

A system needs to be designed to empty out the pebble box more often, as it causes the sump to overflow too regularly. The problem is that nobody will empty the pebble box if the weather is bad, so a new system needs to be designed.

A.7.8 Condition Monitoring (CM)

A.7.8.1 Introduction

The most crude method for operating machines is to run them until they fail, and then to try and repair them in order to make them fit for further service. This method of operation can be very expensive in terms of lost output and machine destruction, and in addition can involve hazards to personnel. It is now well recognized that, particularly in the case of a large plant, it is more economical and operationally satisfactory to carry out regular maintenance. This involves the maintenance of the machine or its various components at regular intervals, to reduce the likelihood of failure during a time when the machine is required to be available for use.

The problem in planning this type of maintenance lies in the choice of an appropriate maintenance interval for the machine. This because the actual running time before maintenance is not constant, but varies from one interval to another, due to differences in the operation of the machine in the behaviour of its components.

Maintenance is thus usually scheduled in such a manner as to ensure safe operation. This means that in many cases, machines are scheduled for maintenance long before any failure is likely to occur. This usually due to its specific operations. This situation wastes production time through executing maintenance when it is not yet realistically needed.

A more satisfactory compromise in terms of maintenance strategy is to carry out preventive maintenance at what may be irregular intervals, but to determine these intervals by the actual condition of the machine at the time. For such condition-based maintenance to be possible, it is essential to have knowledge of the machine condition and its rate of change with time. The main function of condition monitoring is to provide this knowledge.

A.7.8.2 Observations

The ABC Concentrator currently uses CM on most of their critical assets. The organization does however not have a clearly defined CM strategy or policy. Despite the lack of formal documentation, CM is both performed in–house and on an outsourced basis. Table A.2 illustrates some of the services outsourced to the Contractors.

Table A.2: Services outsourced to Contractors

Service	**Contractor**
Hydraulic Packs	Power Systems International
Lube Rooms	Operational Marketing
Jaw Crushers	Metso
Regrind Bearings	SKF
Hoist and Crane	H & H
	Akhanani
Rougher Cells	Autotec
Lubricators	Safspec
Blowers	Airgas
Oil Analysis	OMSA
Mills	Metso
Scrapers	Brelko
Vibration	AFS
NDT Testing	Quest
Cooling Water	Improchem

Condition Monitoring is performed both online through the SCADA system and offline

using various instruments such as infrared cameras, infrared thermometers, accelerometers and oil samples. The online Condition Monitoring assesses the vibration of motors and plumber blocks, pressures and flows in pipes and cells, as well as the temperatures of important components.

Safspec prepares grease reports and AFS prepares Mill reports for ABC Concentrator section. Quest performs ultrasonic testing on mills. Oil analysis reports, prepared by OMSA, generally take a week to arrive after inspection. Thermography is performed inhouse on relevant components (such as motors) every morning by the Mechanical Foreman. Cooling water is checked by Improchem.

A.7.9 Work Management (WM)

It has been observed that the overall Work Management processes can be optimized and streamlined. The following observations were made regarding WM.

A.7.9.1 Documentation

The documentation process that needs to be followed before any task can be done on the plant is a tedious and time-consuming one, however is need not be due to the capabilities of SAP, which has already been implemented.

Firstly a job card is filled out and loaded onto SAP, then a permit is filled out in the lockout room which an operator needs to sign off on. A SLAM document is then filled in while on site and then signed off by a witness. Once the job is done, the permit needs to be signed off by an operator again, the job card needs to be signed by the Foreman and then loaded onto SAP as 'job done' and the SLAM document needs to be taken to a box. The following problems were observed with this process;

- Waiting for operators to sign documents;
- The lockout and permit documents are on one sheet that needs to be filled in completely even if a lockout isn't needed;

A.7.9.2 Follow through and Inspections

The following problem was observed and is believed to happen often. If someone from production sees a problem that he/she believes is electrical and fills a job card for the electrical Foreman and the electrical artisan finds that the problem is actually for another department, the job gets left without any follow up.

The same problem occurs when a piece of equipment is only fixed with temporary measures for some or other reason, there needs to be a process to capture this data to make sure it doesn't get forgotten before the temporary measure fails.

Once a job card is filed and the work is completed, the quality of the work is rarely checked. This gives workers the opportunity to be slack with their jobs in order to finish before the shift ends. There have been many instances where the quality of work was observed to be below standard. It is therefore recommended that inspections are done by the Foreman after jobs are completed or at the very least that spot checks are done by the Foreman.

A.7.9.3 Communication

It has been observed that there is a serious gap in communication between Engineering and Production. There is a blame shifting culture between these two departments. Managers are not always informed of incidents immediately and the tension between the two departments often spill over into open conflict.

A.7.9.4 Planning

Respondents were in general concerned about the quality of planning at the ABC Concentrator. They indicated that there were too many ad hoc meetings which took up a lot of time. Certain meetings such as the monthly safety meeting were attended by all employees, many respondents however indicated that these meeting should only be attended by relevant representatives such as the Section Engineers and not all Foremen. certain employees believe that only a select few should attend the meetings (such as only the engineers and not their Foremen). Gantt charts are too optimistic with employees not being aware of how long it takes to procure orders. This results in tasks not being kept to schedule since too much pressure is placed to finish quickly. Furthermore, there are planned maintenance jobs, unplanned maintenance jobs and in-rush maintenance jobs (breakdowns which need urgent attention). By the amount of in-rush maintenance occurring, it is clear that planning of maintenance tasks is not performed very well.

A.7.9.5 Callout Management

During after-hours, should a call-out be potentially necessary, the Shift Leader (Production side) calls the standby officer (Engineering side) who then decides if the call-out should be placed. If the call-out is to be placed, the standby officer phones the appropriate person such as a fitter. Sometimes the person may need another person such as a rigger to aid him / her. In this case, the standby officer is called to approve the call-outs of both employees. If the call-outs are approved, each employee receives pay for the equivalent of at least four hours of work, irrespective of the real amount of time spent working. Should the call-outs be declined, the job waits for the next working day. In the actual case witnessed, a fitter was called for Pump 558, but he also required a rigger. Eventually the standby officer decided that the cost was too expensive for call-outs and left the job for the next working day.

A.7.10 Asset Financial Management

A.7.10.1 Introduction

Asset financial management has an impact on the at least the following PAM areas:

1. **Work Management:** Balancing overtime, deadlines and many other work management aspects depends on financial management and having the correct data when one needs it.
2. **Shutdowns:**Shutdowns: Shutdowns often require large amounts of capital or conversely can disturb production thus negatively influencing production rates and outputs. Part of preparing the organization for these shutdowns is adequate financial planning and management.
3. **Asset Management Life Cycle:** Financial Management plays a large role in determining the cost of an asset through its life cycle. Furthermore, it can be the deciding factor when selecting between multiple assets and alternatives. Thus, AMLC relies heavily on a strong financial management system.
4. **Defect Elimination:** The cost of removing defects versus the reduction in failure costs is a critical calculation requiring both financial management and defect elimination knowledge. Therefore, these two practices go hand in hand, especially on a strategic and action plan level.

A.7.10.2 Cost accountability and Granularity of budgets

Foremen at ABC Concentrator are concerned with their lack of budget control. The lack of control is among other reasons the result of the way in which Cost Centres are set up in the financial system. Foremen are currently unsure of exactly how much they have available to spend as budgets are set at a Cost Centre as opposed to Foreman level. Each of these costs centres catered for a certain section of ABC Concentrator. Contrarily, the responsibilities of Foremen often overlapped numerous sections or were limited to only parts of a particular section. Confusion and irritation is widespread and Foremen often accuse their peers of depleting “their” funds.

In an attempt to address the apparent lack of cost accountability the Finance department indicated that Foreman specific budgets were developed for the next financial year. SAP was set-up to support this and it would thus be possible to develop Foreman specific cost reports on a weekly and monthly basis.

The effective management of change will be paramount to the success of this undertaking and the benefits of higher levels of Cost Accountability need to be clearly communicated to the Foremen to facilitate compliance.

A.7.10.3 Asset categorization

No evidence could be found of any asset categorization table or method. The implication is that decision makers are struggling to decide which assets and spares are more or less critical. In the light of budget constraints, it is not possible or practical to have spares for all assets. The breakdown rates for some assets are however very high and therefore require the immediate availability of spares. Hence, spares need to be ordered and kept in storerooms according to how critical they are considered to be. Currently the composition of critical spares lists is a function of Foreman experience and 'gut-feel'. Although these experiences are invaluable as well as important, this is hardly a scientific or robust approach.

A.7.10.4 Cost-benefit analysis

There appears to be no easy method to conduct costs-benefit analysis. According to Foremen, Metallurgists and Production Operators, they often find it difficult to get assistance when cost-benefit trades-off need to be made and these stakeholders indicated that they are often frustrated by slow responses when requests for cost-benefit evaluations are made.

An example is the overflowing of cells in the floatation section. These cells typically choke and the fail-safe is a sprinkler system that prevents the product from brimming over and going to waste. Unfortunately, the pipes of the sprinkler system are corroded to such an extent that they fail to function at least once a shift. The simple solution is to install plastic piping. This suggestion has been mooted and rejected owing to its cost of implementation. The end result is massive losses of valuable material every shift. Production targets suffer and the belief is that plastic piping will repay itself swiftly by recouping the valuable material which is being wasted daily. Regrettably, the staffs struggling with this problem have been ineffective in their efforts to communicate the situation to top management.

A.7.11 Asset Management Life Cycle (AMLC)

A.7.11.1 Introduction

AMLC looks at the entire life span of an asset from inception to disposal. It takes a more holistic approach at estimating an assets costs and life. Even though an asset may only be used for a certain period of time, its development and decommissioning periods could be equally long. Furthermore, the idea that asset's costs end after purchase needs to be eliminated, allowing the full cost of impact of assets to be realized through AMLC.

AMLC also aids in the continuous improvement strategy. Where regular assessments are used to determine potential opportunities for performance improvements as well as identifying degrading performance. It then schedules and prepares the organization for

the fact that an asset or system may be improved during its life cycle. This is in contrast to the run to failure strategy, or implement and forget.

Lastly, AMLC is not a singular strategy, it employs practices from almost all the other Asset Maintenance Management practices. Only by working together can the full benefits of AMLC be realised. Therefore, one should always think about practices one can apply during the different stages of an asset's or system's life. Asset Life Cycle Management interacts with:

1. **Condition Monitoring:** Though not directly, AMLC makes use of CM during the maintenance phase of an assets life.
2. **Work Management:** WM is important during the design stages of an asset or system. It is almost of utmost importanance during the installation and construction stages.
3. **Facilities, Tools and Workshops:** Facilities, Tools and Workshops play an important role during the design stages. Furthermore, they play a large role in installation and construction.
4. **Shutdowns:** Shutdowns form a crucial role in the Utilization phase of AMLC.
5. **Defect Elimination:** Though not directly, AMLC uses DE for improving current operational systems and assets.

A.7.11.2 Asset Management Life Cycle (AMLC)

After numerous informal discussions and interviews with engineering Foreman, Artisans and Planners, it was confirmed that ABC Concentrator did not have any Life Cycle Management action plan. Not only are the life cycles of its assets not managed with any specific policy or long term vision in mind, but were all unaware of the existence of Life Cycle Management.

Currently ABC Concentrator does not consciously asses the life cycles of their assets. Decisions such as whether to replace or repair assets are made with a narrow-minded view on saving costs. As long as an asset is able to operate, it will be maintained no matter how exorbitant the costs. Even if assets are performing well below their rated performance level, they will be kept in operation to postpone any future capital outlay. Decisions therefore does not take into account present financial (lost production) and energy losses due to the inefficient operation of these assets.

With Life Cycle Management these financial and energy losses should be taken into account when making important decisions. When the basics of Life Cycle Management were explained to the ABC Concentrator staff, the general response was extremely positive. It was further discovered that the foundation for the implementation of Life Cycle Management was already in place. Information such asset failure frequency, performance

and efficiency were already being captured and logged onto SAP. Hence, with the groundwork laid out already, only a conscious effort is needed to adopt, implement and sustain the use of Life Cycle Management at ABC Concentrator.

A.7.11.3 Asset repair register

The Asset Manager at ABC Concentrator has embarked on an audacious yet necessary project aimed at identifying, verifying and in some cases retrieving assets with a total value upwards of R100 million. These assets are generally assets bought at values lower than the company stipulated insurance value (±R5 million). They are thought to be missing, misplaced, off-site or discarded already. However, most have been sent for repairs but have not been returned and/or are believed to have to be lost since. The purpose of this project is to take stock of these assets in a register as to ascertain where they are and it what condition. Furthermore, the information within this repair register will facilitate the implementation of Life Cycle Management.

A.7.11.4 Zero value assets

Often significant capital purchases are needed during major breakdowns. Naturally these "panic buys" have not been budgeted for and are therefore not part of the capital expenditure budget (Stay in Business budget). These assets, though revenue generating assets, appear on the income statement as working costs. They can be entered on the balance sheet, but only at a "zero value" assets. The reality, however, is that these assets have a certain market value as well as amortization rate. This important information needs to be documented somewhere along with its failure frequencies when managing the life cycle of an asset. Failure to do so will render the whole exercise of AMLC useless.

Currently an asset register is being put into place that will document these zero value assets. Along with SAP's inherent functions, which facilitate the implementation of AMLC, the life cycle of these assets can be managed at ABC Concentrator. The foundation for LCM is in place, but emphasis should be put on the importance of this asset register project to ensure the effort is seen through to the end.

A.7.12 Shutdown Management

ABC Concentrator gets shut down for 48 hours every month to do general maintenance and repairs. However nobody understands or knows why the Shutdown is specifically performed monthly, other than the fact that it is due to maintenance.

The following observations were made during the Shutdown procedure.

A.7.12.1 Planning

The general procedure of the Shutdown is as follows;

- Artisans give a list of jobs they would like to perform during the Shutdown to the Foreman;
- Contractors do inspections on the equipment every month and decide what happens in the next Shutdown. This list also gets given to the Foreman; and
- The Foreman discusses this list with the section Engineer for approval.

However there seems to be no specific plan and official schedule in place before the Shutdown takes place. Recently documentation has been created to help ensure that the correct documentation and tools are in order before the Shutdown commences, which is believed to have contributed to process improvements. It is recommended that this plan be more detailed in terms of dedication of tasks to specific people and scheduling the Shutdown to ensure that the plant started up on time. Activities that are planned for the Shutdown should be prioritized and should also be realistic to ensure completion before the Startup. As an example, the beams on the vibrating screens were broken, yet they were only fixed after the Shutdown.

A.7.12.2 Shutdown Procedure

There is an official lockout procedure for the actual Shutdown that has been designed by a process metallurgist. This lockout procedure includes the sequence for equipment to be locked down to ensure the safety of the personnel and equipment.

A.7.13 Asset Supply Chain Management (SCM) (Materials Management)

Supply Chain Management is the management of material and information flows both within and between organizations. It includes the movement and storage of raw materials, work-in-process inventory and finished goods from point of origin to point of consumption. The goal of SCM is to create sourcing, making and delivery processes and logistics function seamlessly across the supply chain as an effective chain. The focus of the audit in terms of supply chain is on Material Management at the ABC Concentrator.

The supply stores at the ABC Concentrator are well managed. The Material Requirements Planning (MRP) done through SAP automatically handles all requests for stock and ordering of stock. Once stock reaches its minimum levels, MRP reorders the stock item. The Supply Officer checks SAP to ensure consistency. Furthermore, nothing goes out of the stock stores without approval (by signing) from the relevant person at the

stores. If stock is required after-hours, then a requisition is placed immediately and the order processed the next working day.

The stores are located quite far away from ABC Concentrator sections. Previously, there used to be two stores at opposite ends, but only the current store was kept to simplify stocking. It may be advisable to move stores to a more central location, but the Supply Officer believes that with the current delivery system (where vehicles deliver stock), this is not required.

Large spare parts are kept outside due to their size. Smaller, expensive spare parts such as copper items are locked away. Commodities such as coffee are also locked away. The remainder of the spare parts (smaller, less expensive items) are stored on shelves in the stores. All items kept outside are stored under a roof.

It was noticed that large items such as re-liners were stored outside without cover in the Chrome Handling section. Although this is not part of ABC Concentrator, it is important to keep in consideration that items may rust or wear due to exposure to weather conditions. Considering that re-liners are important components that ideally should not be installed after initial wear, the recommendation is to continue covering all these parts either with a roof or in a shed.

Items are classified as either A, B, C, D or E depending on their criticality (which is decided by engineers and production employees) with A-parts being parts that result in the plant stopping should they fail (highly critical with long lead times) and D-parts and E-parts being redundant stock. The D-parts and E-parts is often sent to other plants that require them if the ABC Concentrator plant has no need for them. Stock takes of stores are performed on a continual basis to ensure correct stocking and identify misplaced stock. Stock takes are performed on the following basis:

- A-stock: monthly
- B-stock: every 3 months
- C-stock: every 6 months
- D-stock: annually
- E-stock: annually

One stocktake performed for the stores in September had a 96% accuracy. Random spot checks are also performed on stock. This is evidence of a well-managed stores system.

All stock is codified for identification and location purposes with bar codes and serial numbers. Codification also makes it easier to purchase stock in bulk. If stock does not have a code, forms are filled in and head office investigates the matter further. However, no form of electronic tagging and tracking such as RFID is evident. Currently, once spares leave stock stores, it is no longer monitored by stores. Implementing electronic

tracking technology may be useful in monitoring stock, preventing theft and easing the management of stock.

According to the supply officer, the end-users (engineers, Foremen and anyone requesting stock) determine the minimum / maximum levels for their stock. This may result in bias since end-users may request more stock than necessary to ensure they always have stock available. The supply officer is capable of monitoring stock trends and to see how many of each part is removed from stores each month. The end-users would need a good reason to raise the minimum / maximum levels. However, this is potentially a form of bad control since stock may be over-stocked. The stores pay for storage costs and the stock only becomes the end-user's after he or she paid from the cost centre.

The new Supply Officer has limited access to SAP at the moment which is problematic since it restricts her activities. However, the reason for limited access is acceptable since she is new and is still learning the processes.

One very important problem for the stores is the deletion of pickings. When a request for parts is placed and the stores employees are required to place the stock in the post boxes for collection by end-users, often the employees merely delete the request for pickings. This happens on the outbound side of the stores. The reason for deletion of pickings may be that employees are too lazy to actually follow through on the request. It is a long process to identify if pickings were deleted since the pickings are no longer on the system after deletion. However, the Supply Officer is still able to identify, after some effort, who deleted the pickings. Currently, she prints the list of pickings before handing them over to the relevant employees for processing and then she compares the final list of pickings at the end of the day with the first list. In this way she can determine what pickings have been deleted and follow-up.

A.7.14 Asset Information Management

Global distribution channels, numerous international operational sites, and closely integrated sourcing arrangements have changed the way hundreds of organizations do business. A key component of managing these organizations is Information Technology. Over the past few years, many companies have embraced a new class of planning and resource management software systems (such as SAP) to integrate processes, enforce data integrity, and better manage resources. These package systems are broadly classified as Enterprise Resource Planning (ERP) systems.

ERP software integrates information used by the accounting, manufacturing, distribution, and human resources departments into a seamless computing system. A successful ERP system can be the backbone of business intelligence for an organization, giving management a unified view of its processes.

The organization uses SCADA to monitor plant processes online. It uses SAP as its CMMS and MRP within SAP to handle stock and part orders. These systems are backed up regularly. SAP has many functions that can be used, but some of these functions

which would be useful are not being utilized. A typical example is the methods currently used to manage job cards and permits. There is no easy way to view which job cards have been scheduled by who and rescheduling of jobs during breakdowns or shut-downs. There are also no checks for job clashes through SAP other than manual checks.

Permits used to be printed on job cards through SAP. This simplified the job process by allowing an artisan to arrive at the Planners' office, to request a job and eventually to leave with all the documents such as job card, permits and SLAM documentation in one folder. However, this has changed to a system where job cards, permits and SLAM are handled separately and this causes inefficiencies in the process.

Some Foremen have access to SAP. However, after three months of not using SAP, access is revoked. Training for SAP is then required in order for these employees to access SAP again.

In addition to the non-optimal utilization of SAP functionality users did express some frustration with the functioning of SAP as a system. These problems are both system and user related. The following are typical examples of the above:

- System speed – this was confirmed when it took a number of minutes to develop a simple report on job card confirmation;
- A number of examples was found were users entered the incorrect information into SAP such as call-outs and breakdowns (PM02) being placed as normal maintenance (PM01) activities; and
- Jobs that require two separate job cards were also logged under one job card such as work on two separate mills. In certain instances, employees have entered start dates for later than the date work was actually done in order to prevent backlogs of jobs. They are also striving for 100% job return which is achieved by entering incorrect information.

Paper work seems to cause quick jobs to take quite a long time. For every job, a job card is first created on SAP at the planner's office. Thereafter, a Permit to Work and / or a Lockout form is filled at the applicable site of the section in which work is to be performed. This Permit to Work and / or Lockout procedure needs to be signed by an operator. Afterwards, SLAM (Stop, Look, Assess and Manage) is performed at the site of the job required and then finally the job is performed and signed off again by an operator. The following problems are identified relating to this system:

- Operators may feel their jobs are more important and take a long time before signing the form;
- Paper work is tedious and time-consuming for minor jobs;

- Currently, a simple job that only requires a Permit to Work also requires the Lockout section to be filled in with "N/A" for each line. This is time-consuming. Lockout and Permit to Work sections should be separate sections in the book to save time;
- Forms such as the SLAM are not always filled in onsite, but rather in the office before the employee goes to the site (no control over where employees fill in forms); and
- Pebble beds are emptied every hour, but the paper work and cleaning easily takes up to 30 minutes.

A.7.15 Safety, Health and Environment

A.7.15.1 Safety, Health and Environment

It is clear that this plant is very focused on both Health and Safety. The following observations were made regarding the Safety and Health aspect of Asset Management:

Safety awareness during meetings All activities and meetings that take place are centred on safety and health. Every shift on the plant begins with a 15 minute safety meeting with the following agenda;

- Safety Statistics with regard to Lost Time Injuries and minor injury free days (Target = 365);
- Monthly safety topic (e.g. Mobile machinery);
- Hygiene topics (e.g. Illumination and Pollution); and
- The problems from the previous shift.

Health and Safety Policy There are very clear health and safety policies that are visible on all the notice boards in each department. These safety messages are all centred around to the following three central themes:

- Zero Harm;
- Learning (no repeats); and
- Simple Standards

Safety Officers There is only one safety officer responsible for all of the sections on the whole plant and only in the morning shifts. Although there is no safety officer on the plant on the afternoon, night or weekends shifts, there is a one on standby. Safety reps are however present on these shift where safety officers are absent, but they have other primary jobs and can't focus on the safety aspect, therefore the workers are slack with safety. This lack of safety adherence was present specifically on the night shifts.

Safety Inspections Safety inspections are done daily (barring weekends) by the safety officer and sections of the walking platforms around the plant are checked monthly to make sure they are stable and not corroded. These inspections are then recorded to ensure that any problems are followed up. The safety officer also does spot checks on a daily basis to check that the employees are adhering to all of the safety rules.

Incidents and Investigations If an incident takes place that results in injury, the heads of departments are notified of the accident via email. Immediately after this incident takes place, photos are taken of the scene for the investigation. This investigation takes place within 72 hours of the incident in a meeting to determine causes and discuss mitigation strategies for further incident. The safety officer decides what further actions should be taken with regard to the incident and again notifies all heads of departments via email once the investigation is over.

All other incidents regarding equipment and other plant related issues are also reported, documented and then placed in a box at the end of each shift. These incidents are discussed in the morning production meetings in order to ensure that the problem is being attended to with the proper documentation.

Safety Documents Permits are filled out for every job that is done on the plant, which an operator signs off on before the job can be done. The operator also signs once the job is done for record keeping purposes. Official lockout procedure is also included on the permit documents, allowing for a safe working environment once the equipment is off-line. Special permits are required for the following jobs:

- Working at heights
- Lifting
- Hot works
- Working in confined spaces
- Cutting

Before these permits can be issued, extra documentation that requires information about the people needed for the job, the spotters and the tools, needs to be filled in with any special equipment needing to be signed off. The workers also require documentation showing they have the right training before these permits can be filled out.

A SLAM (Stop, Look, Assess, Manage) book is also taken to the site where the job is to be done to be filled out before the task is started. This document contains information about the safety risks that are present at the site where the job is to be done. After this document is completed, a witness needs to sign to validate that the form was filled in properly. These SLAM documents are also placed into a box at the end of every shift. However it was observed that many of the workers find this SLAM document difficult to fill in. It is therefore recommended to simplify this document and condense some of the information.

Safety Officer's Safety Concerns The safety officer's greatest concern are the workers' attitude towards safety. The safety officer feels that the major safety concern is '*'People taking breaks from safety"*. These include workers not wearing their safety glasses and making excuses such as *"Im just cleaning my glasses."* In general the safety officer would like to see more adherence to the safety rules.

Safety Meetings There are many safety meetings that take place on this plant, however safety is discussed in every other meeting as well. They are as follows;

- 15 minute safety meetings before every shift
- Standard committee meeting for all safety personnel every Wednesday
- Planned safety meetings every 3 weeks with Foremen and supervisors
- Monthly meetings with everyone which lasts all day

It was suggested that all of the Foremen should not attend these monthly meetings, as they take up too much time for people that aren't needed and rather that only one Engineer should be present to answer for all the issues regarding Engineering.

A.7.15.2 Environment

In terms of environmental protection, ABC Concentrator outsources all of their energy/carbon footprint calculations, along with their radioactive disposal.

However on the plant specifically there are environmentally friendly practices, such as the disposal of the waste. For example, the domestic and hazardous waste are disposed of separately. The wood and the scrap metal from the ore are picked up by EnviroServ to be taken to a salvage yard, where the wood gets burned off and the scrap metal sold off.

A.7.16 Asset Care and Maintenance Tactics

Maintenance tactics plays a significant role in an asset's life and a large portion of that asset's costs and life span can be reduced by selecting the appropriate maintenance tactic.

Therefore, a strong implementation and well performing Maintenance Tactics program within an organization goes a long way in enabling that organization to receive benefits from Asset Management practices.

Something as trivial as good housekeeping can male a huge contribution to caring for assets to prolong their life span. *"5S"* is implemented in the workshops on this plant, but it is lacking on the plant itself, however *"5 Why's"* is implemented across the whole plant.

There also seems to be no official maintenance policy, other than the fact that maintenance is performed on Sundays. The whole plant seems to work almost entirely on reactive maintenance. If there is a problem with a piece of equipment on a weekend or an afternoon or night shift (when no Engineers are on the plant), a call-out is not allowed to be made unless there is a breakdown, therefore the equipment is only attended to once an Engineer is on site again. The concern is that the problem on the equipment could escalate to a breakdown, which could have been avoided if a proper maintenance strategy was in place, in other words assets are pushed until they fail before they are attended to on shifts where Engineers are not on site.

There are many issues/problems with equipment that occur frequently on the plant and therefore this is the perfect opportunity to perform either predictive or preventative maintenance to decrease the frequency of these events.

A.7.17 Risk Management

A.7.17.1 Risk Management policy and practice

There is currently no risk manager of any form at the ABC Concentrator. The organization also does not have a risk management policy in terms of assets. There is no official document describing a risk plan in terms of assets. Most risk plans are merely safety orientated. There are also no official risk mitigation plans in the event of assets failing. As already indicated most of the maintenance performed seemed to be reactive (repairing / replacing assets only once they have failed).

Condition Monitoring is performed extensively on the plant, but there was no evidence of it being documented in a formal Condition Monitoring policy. Should a motor indicate potential failure through unusual vibration, the Mechanical Foreman arranges to have all necessary parts available. They then wait until the next shutdown or stop to replace the components about to fail. This procedure is a form of planned maintenance and, more specifically, a mixture of basic preventative maintenance and predictive maintenance, but it lacks formal documentation and policy. Furthermore, preventative maintenance or even predictive maintenance could be implemented to a greater extent at the plant.

A.7.17.2 Information System risk management

In terms of risk management of servers, the PLC room has two OS servers where the plant can operate off only one of the servers if necessary. This forms a redundancy which protects the plant from not operating due to a server failure. Weekly backups of these servers are performed and IT also performs their own backups of the software.

A.7.17.3 Specific observed risks

Finally, the audit team observed the following risk areas, that are highlighted for the purpose of this report:

- Many water leaks in piping and makeshift jobs which are not performed very well. Figure A.5 highlights water leaks and a makeshift job performed using a rag to seal a component.

Figure A.5: Water leaks and poor makeshift jobs

- Cables and beams across walkways;

- Non-functional fans and air-conditioning in the PLC room;
- Corroded support structures (shown in Figure A.6) and pipes;

Figure A.6: Corrosion of structures

- Loose bolts on motors such as at the Secondary Scavengers section of Module 1 which cause motors to vibrate more than they should as illustrated in Figure A.7; and

Figure A.7: Loose bolts on motors

- Reverse parking accidents still occur;

A.7.18 Criticality Analysis (CA)

No CA has been performed in recent years, to determine which assets are most critical to focus on. Criticality of assets is determined more on an experience-basis where the mainstream components are generally considered most critical (failure of these assets result in the plant stopping).

There is also a list of changeover assets to help identify which assets are replaced frequently. According to a Section Engineer, replacement of assets are determined through:

1. The number of callouts on specific equipment;

2. The experience of Artisans,
3. The general observable condition of equipment; and
4. By general visual inspections.

A.7.19 Facilities, Tools and Workshops

A.7.19.1 Introduction

Facilities, tools and workshops form an important part of any industrial organization. Effective management of facilities, tools and workshops allow for effective management and control over processes and products. Furthermore, benefits of using procedures within facilities, tools and workshops include an improvement in health, safety and environmental factors. More direct benefits include improvements in:

- Overall equipment effectiveness;
- Optimal equipment reliability;
- Equipment availability; and
- Costs management.

A.7.19.2 Observations

As already indicated "5S" is implemented within workshops, but not on the plant. The workshops are cleaned when they appear dirty and this cleaning occurs during the afternoon before the end of the morning shift.

There have been complaints of lack of both critical spares and tools. When a shutdown occurs, there are often tools not available when they are required. Usually valves are missing or not available for the shutdowns. This results in delays and tools should be managed more appropriately. Workshops also complained about not having enough welding machines.

Furthermore, there were complaints of pipe leaks being repaired with a clay substance with no further action to repair the pipes appropriately. The clay substance used to stop leaks then wears off within a month's time. When pipes are repaired and clamps are used, new clamps are often not available.

Lists of critical spares are prepared by Foremen and are then handed over every month to the Engineering Manager. However, some Foremen do not hand over their lists. This results in an inaccurate or outdated list of critical spares. The non-availability of critical spares has a detrimental impact on the asset management and ultimately production.

Each artisan has his or her own set of tools in the workshop which are locked in cupboards. There are lists of tools on the cupboards to identify what is missing. The Foremen inspect the tools, workplaces and do stock take of tools once a month. Although there is no name-tagging or formal identification of tools belonging to each artisan, Artisans spray paint their tools to help them identify which tools are theirs.

Tools are often shared by Artisans and Contractors do not bring in their own tools, but rather use the workshop's tools. Upon return of the tools by Contractors, the Artisans inspect the tools. When tools go missing, as they sometimes do, they are replaced by ABC management (not at the expense of the Artisans). Previously, personal tools were allowed to be brought into the company, but due to theft of tools or misplaced tools, this was banned and Artisans are only allowed to use tools allocated by the plant.

Tools are not tracked using any form of tracking technology. They are merely handled by Artisans with each artisan having his own set of tools. When a call-out is placed, Artisans fetch their own tools themselves. Calibration of tools is done in-house and checked every few months by OEM, depending on equipment type.

A.7.20 Contractor Management

A.7.20.1 Introduction

Contractor Management is the process of managing outsourced work performed for an operation / organization. Organizations in both the public and private sectors are facing increasing pressure to reduce costs and improve financial and operational performance. New regulatory requirements, globalisation, increases in contract volumes and complexity have resulted in an increasing recognition of the importance and benefits of effective contract management.

Contractor Management interacts with:

1. **Facilities, Tools and Workshops:** Facilities have to be provided for Contractors when they move on-site.
2. **Asset Management Life Cycle:** Contractors need to share the same plans as ABC Concentrator regarding the life-cycle plan for the asset involved.

A.7.20.2 Minimal influence on contractor selection

A big complaint from both the Engineering and Production departments is the selection of Contractors by Anglo Platinum's central supply chain function. Contractors that have been used for years are often replaced without the knowledge of ABC Concentrator management and staff. Long standing work relationships are then disrupted along with a loss of continuity within the plant. These new Contractors need to be introduced to the plant

and made aware of the subtle differences between ABC Concentrator and other platinum Concentrator plants where they might have worked before. This requires manpower and is often time consuming. In addition, the turnover rates of these Contractors are high resulting in massive inefficiencies at the operational plant level.

A.7.20.3 Contract Administration

Foremen were f by the burdened associated with managing contractor administration and paperwork. At present each Foreman is responsible for ensuring contractor paperwork such as the safety files are up to date, without the expiration of any documents. Within the context of their day-to-day responsibilities this additional responsibility if often not attended to. This dilemma manifests itself with the inability of Contractors entering the plant or completing work due to invalid paperwork. Work delays and frustration ensue.

A.7.20.4 Maintenance of floatation cells outsourced

A lump sum is paid to a contractor for maintaining all the cells in the floatation sections. The contractor is responsible for the maintenance, as well as the replacement of any cell parts that are inoperable. Unfortunately this arrangement deters the Contractors from replacing cell parts as it depletes their given lump sum. Their incentive is therefore to run cells till failure in order to get maximum life out of them. Furthermore, Engineering seldom or never engages in discussions with the contractor as to which cells are most critical.

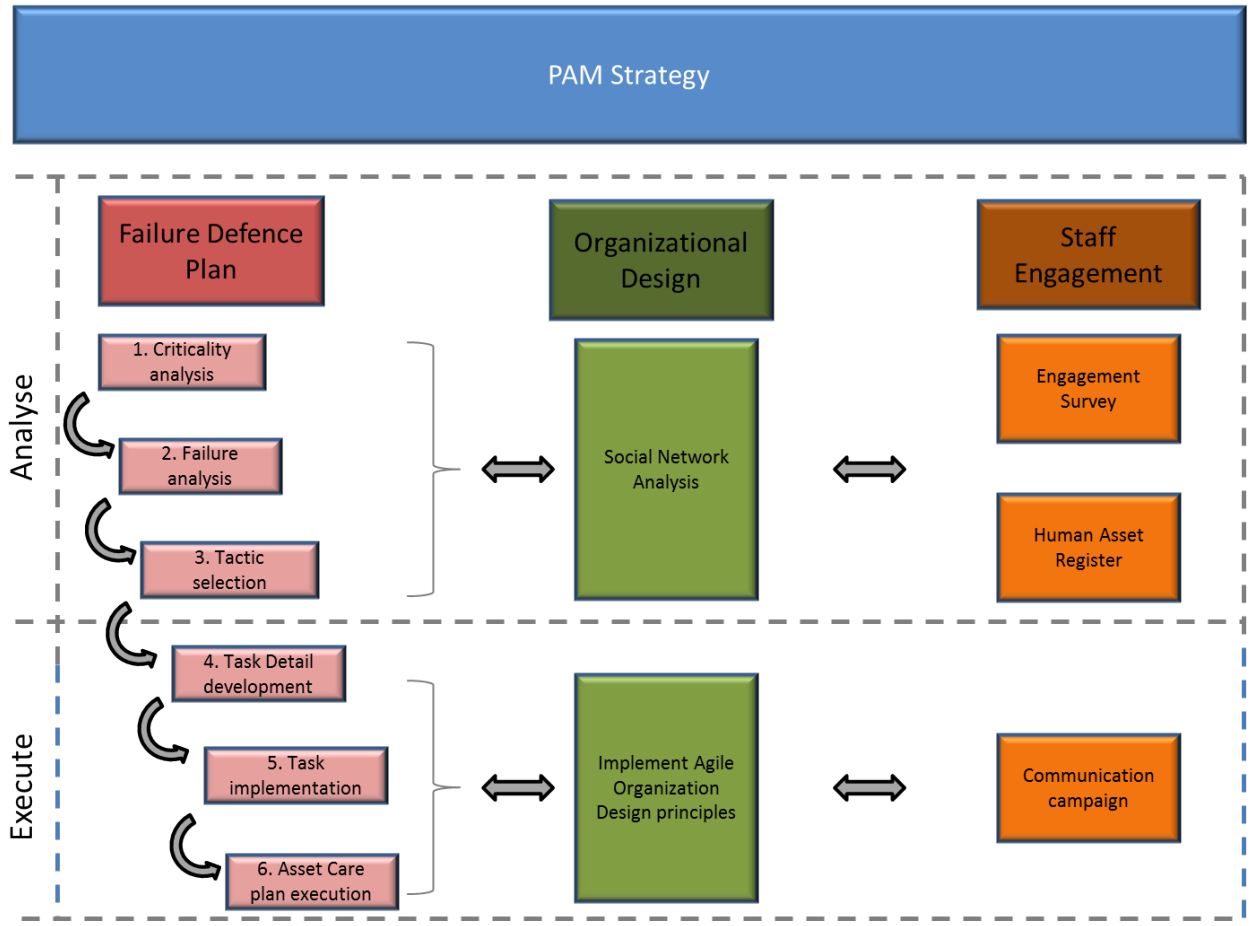
A.8 Detail discussion of the Recommendations framework

The purpose of this section is to present a detailed recommendations framework. In Section A.5, a prioritized and summarized version of this framework was presented. The research team is of the opinion that the implementation of this framework would make a significant contribution in the quest to achieve the ABC Concentrator PAM vision.

The recommendations framework is presented in Figure A.8, and consists of four major elements:

- The development of a PAM Strategy;
- The development of a PAM Failure Defence Plan;
- Organizational Design optimization; and
- Staff Engagement.

Figure A.8: ABC PAM optimization recommendation framework



It is important to take cognisance of the fact that these elements are all interdependent and apart from the development of the PAM strategy that supersedes all other elements, these elements should be implemented in parallel. In the next section each of these elements are discussed and in more detail.

A.8.1 The development of a PAM strategy

Physical Asset Management Strategy (PAMS) is a long-term optimized approach to the management of assets, derived from, and consistent with, the organizational strategic plan and the asset management policy. Furthermore, the PAMS converts the objectives of the organizational strategic plan and the asset management policy into a high-level, long-term action plan for: the assets and/or asset system(s), the asset portfolios and/or the asset management system.

These high-level, long-term action plans for the assets and the asset management objectives are normally the outputs of the asset management strategy. These elements together form the basis for developing more specific and detailed asset management plans.

The project team strongly recommends that the ABC Concentrator management team should develop an operation specific PAM strategy as a point of departure. The strategy should be clearly aligned to ABC Concentrator business strategy. The strategy development process should be as inclusive as possible and the observations and recommendations made in this study could be used as input during the definition process. In the absence of a clearly defined and communicated strategy and objectives it would be virtually impossible to achieve the ABC Concentrator PAM Vision as set out in Section A.2.1.

A.8.2 The development of a Failure Defence Plan (FDP)

The FDP consists of six sub-elements:

1. Criticality Analysis;
2. Failure Analysis;
3. Tactic Selection;
4. Task Detail Development;
5. Task Implementation; and
6. Asset Care Plan Execution.

Elements one to four mainly involves analysis, while elements five to seven requires and execution focus.

A.8.2.1 Criticality Analysis (CA)

In line with the PAM strategy the PAM team should identify the most critical asset management opportunities and risks. It is extremely important to note that the CA is an inclusive process and that representatives from all relevant departments should as far as possible be involved during this phase.

A.8.2.2 Failure Analysis (FA)

After the identification of the most critical assets (normally the top 15%), the organization should initiate the FA phase. FA involves a formal procedure of determining the failure modes, effects and criticality of failures.

During the FA phase the following steps are typically followed:

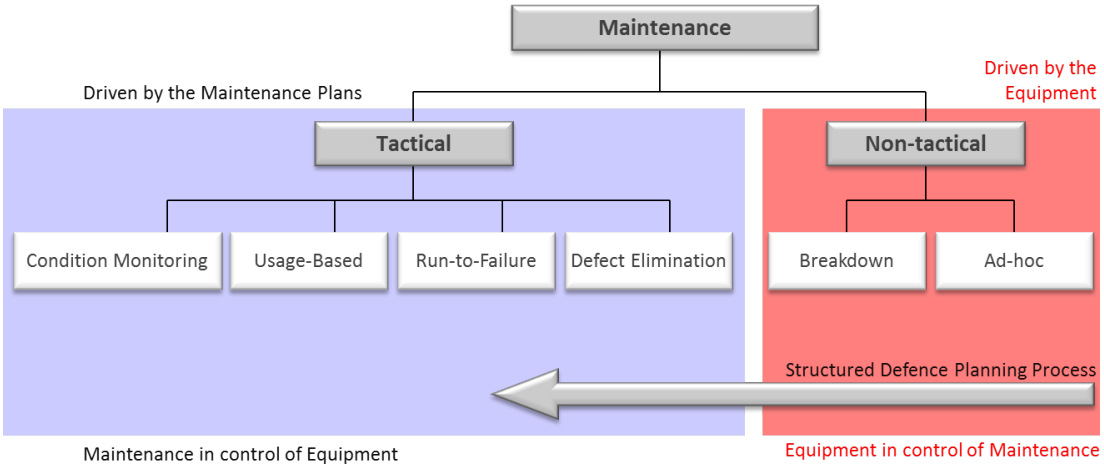
- Analysis of all the potential failure modes of the various parts of a system;
- Analysis of the effect these failures may have on the system; and
- Identification of methods to avoid the failures, and/or to mitigate the effects of the failures on the system.

The following questions are typically asked to determine credible failure modes and their associated consequences:

- How can each part conceivably fail?
- What mechanics might produce these modes of failure?
- What could the effects be if the failure did occur?
- Is the failure in the safe or unsafe direction?
- How is the failure detected?
- What inherent provisions are provided in the design to compensate for the failure?

FA is a comprehensive process designed to identify potential significant and credible failure modes associated with equipment or systems being assessed. The failure mode describes how a system may fail and includes all possible causes ranging from operator errors, deficient management systems or strategies. The frequencies, as well as potential production downtimes or cost effects, associated with each of the identified failure modes are recorded. Furthermore, the likelihood of detecting these failure modes prior to actual failure are also documented.

Figure A.9: Maintenance tactic continuum



A.8.2.3 Tactic Selection

Once the FA phase has been completed the PAM team should select a maintenance tactic for each an every one of the critical assets. Figure A.9 illustrates the continuum of maintenance tactics. It is strongly recommended that the organization should not choose the tactics on the far right of the continuum. Equipment as opposed to the asset management team is in control when these tactics are chosen.

Irrespective of the outcome of the CA and FA the project team is of the opinion that the PAM team should consider the following action steps regarding Defect Elimination and Condition Monitoring.

Defect Elimination (DE) DE can be thought of as a systematic approach where the root cause of a problem is identified in order to find an appropriate solution to the problem, by making use of corrective and proactive actions. Eliminating these defects will increase productive capacity and the overall capacity of the asset.

It is clear that there is no strategy or policy with regards to DE on this plant. Rather there is a culture of waiting for a piece of equipment to break or for something to happen that results in a breakdown before repairs or maintenance takes place. These equipment failures can be mitigated through the identification and elimination of these defects through the appropriate steps.

A defect can be eliminated by following the guidelines adapted from the Anglo American Asset Management Manual. These are the core actions of the defect elimination strategy adapted from the Sigma Six process. These actions are elaborated on below:

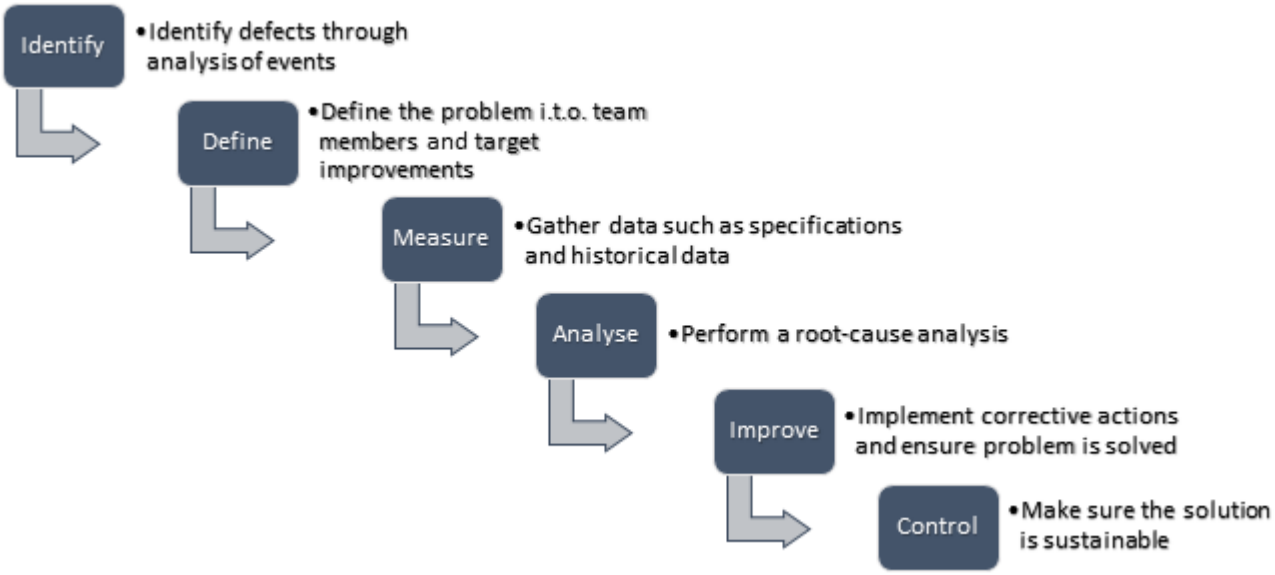


Figure A.10: Defect elimination strategy

- **Identify** There are various mechanisms through which defects can be identified, which can be grouped into three categories. They are as follows:

  Operating Performance Identifying defects in an operational performance context involves a reviewing process. Production and maintenance data is investigated to potentially highlight deficiencies or repetitive failures. Typically a loss analysis will be conducted based around the following categories:

  1. Equipment causing the most loss hours (or production);
  2. Equipment with the highest frequency of failure;
  3. Equipment resulting in the highest maintenance cost; and
  4. Equipment not performing to specification.

  Discussions with plant or operation specific personnel are valuable sources of information regarding the identification of defects. It is unwise to underestimate the insight given by personnel on problems encountered, as it can lead to defects that would typically not be found through the above categories.

  Work Order Feedback Although the rectification of failures is managed through the Work Management process, it is an ideal place to identify reoccurring failures that are caused by defects. The feedback received on failures may also warrant further investigation, enforcing the requirement for thorough and complete feedback reports. These failures are then managed using the DE process.

  Other Systems Defects can occur, or are observed, during routine operation of assets that result in a reduction in productive capacity. Typically these defects may be identified via:

1. Downtime;
2. Significant safety or environmental incidents;
3. Routine management and safety inspections and observations;
4. Audits; both internal and external; and
5. Forms part of continuous reliability improvement.

It is important to note that many defects can be found through routine inspection.

- **Define** Once the problem has been identified we need to define the defect in quantitative terms avoiding opinions and broad statements. A proper definition defines specific goals to be achieved which lays down a road map for accomplishing meaningful results and enables progress and improvement measurement. It also enables the identification of the team members and time scales. Often this team will have to further define the defect by asking the following questions:

Table A.3: Defect Elimination Problem Definition

Field	**Value**
Who	With whom is it happening?
What	What can you see that causes you to think there's a problem?
Where	Where is it happening?
When	When is it happening?
Why	Why is it a problem? (not why did it happen)
How	How is it happening?
Safety Impact/Risk	What safety impact/ risk can or does it cause?
Environment Impact / Risk	What environmental impact/risk does it cause?
Cost Plus Lost Revenue	Determine the cost benefits in possible.
Frequency	How often does this happen?
Improvement Target	What should the result look like?
Due Date	When should the defect be eliminated by?

- **Measure** The approved defect definition serves as input to the measure step in the process. The team meets formally to identify the baseline against which the future performance will be measured to determine progress. A baseline can be established by:

  1. Utilizing existing data:
     - Observe - Observe the process, talk to the people, collect evidence and confirm information.
     - Back to basics - Study specifications, standards, manuals, drawings and any other relevant documentation.

  - Historical data - Study production logs, maintenance history, time sheets, material usage, asset conditions and any other relevant data.

2. Gather new data:
  - New measurements.
  - Event recording.
  - Problem and process mapping.

With all the data collected the team must check the suitability of the data and information.

- **Analyze** *Assess and Prioritize Risk* Once defects have been identified, they must be stored in a single defect register. This register will typically be a table with the following information;
  - The defect;
  - The defect's risk;
  - The person in charge;
  - The team assigned to fix the defect; and lastly
  - The date to commence repairs of action.

  However, before these defects can be ranked according to their priority, a risk assessment must be conducted on each defect. The risk assessment is used to rank multiple defects in order of urgency. The defect with the greatest risk needs to be dealt with first, then the second highest and so on. The general risk assessment is calculated by multiplying the probability of the defect causing a failure within its operating system with the severity of the failure, should it occur. The process of establishing the priority also forms part of selecting the appropriate tactics to be selected.

  The ***Root Cause Analysis*** (RCA) process embodies the main idea behind DE. RCA applies a methodology to enable a standardized process by which root causes, or defects, can be identified. The effectiveness of DE relies on an accurate and effective RCA process and the actions which are chosen to correct or mitigate defects. The analysing step aims to identify the top causes that must be controlled in order to achieve success. If too many causes are identified, then the team has either not isolated the primary causes, or the project goal is too ambitious to achieve success with a single project. Root-cause analysis can be utilized in two maincols situations, listed below:

  1. Failure occurred and needs immediate resolving; and
  2. A number of failures exist and systematic eradication of these problems need to be done.

There are numerous methodologies or tools which can be used to aid in identifying the causes, methods such as:

1. The Pareto Analysis;
2. The Fishbone diagram; and
3. The 5 Why's analysis;

In the event of a single failure, a Pareto analysis can be neglected. A Fishbone diagram is used in conjunction with 5 Why's analysis to resolve the single issue. Where multiple problem areas exist, a Pareto analysis is first completed before moving on to solving the most important problems with Fishbone diagrams and 5 Why's analyzes. Looking first at systematic improvement with multiple problems, Pareto analysis is used to give a clearer picture and offer a strategy on where to start the DE process.

- **Improve** Once the root cause(s) has been identified, a preferred suite of solutions should be developed to address those root causes. These solutions must then be evaluated and implemented. Each solution will have a solution specification completed prior to the evaluation. Solution Evaluation Criteria must be confirmed prior to the solution being evaluated. These criteria will be site specific but would typically include:

  - How well the solution addresses the root cause.
  - SHEC implications.
  - Cost to implement.
  - Ease of implementation - cultural change, technology etc.

  The solution will not be closed out until all action items are completed and the targets have been met. If the solution fails to meet its objective in the expected time frame the DE team will review, in the following order:

  - The solution implementation to ensure the solution was implemented as intended;
  - The solution design to ensure it addressed the identified root causes;
  - The root cause analysis to ensure that all root causes were properly identified; and
  - The problem statement to ensure the correct problem was analyzed.

  The DE team will report back to the Defect Elimination Management Team who will determine and assign follow up actions if required.

- Condition Monitoring

  There is a wide acceptance of Condition Monitoring, but there are a number of limiting factors, most coming from a historical context of the application being seen as the answer to all of maintenance's needs:

  – CM is often used as a "stand alone" maintenance concept;
  – Frequently CM is simply used for Failure Prediction, little else is asked for or expected;
  – Too often CM has been driven from the bottom upward;
  – CM alone does not provide for reliability; and
  – CM does not prevent failure, it detects and predicts it.

  It is extremely important to realise, that even if CM programmes are successful in detecting all problems, if they are not supported by the DE strategy, all value is lost.

  Figure A.11 displays the Work Flow for a typical CM Programme.

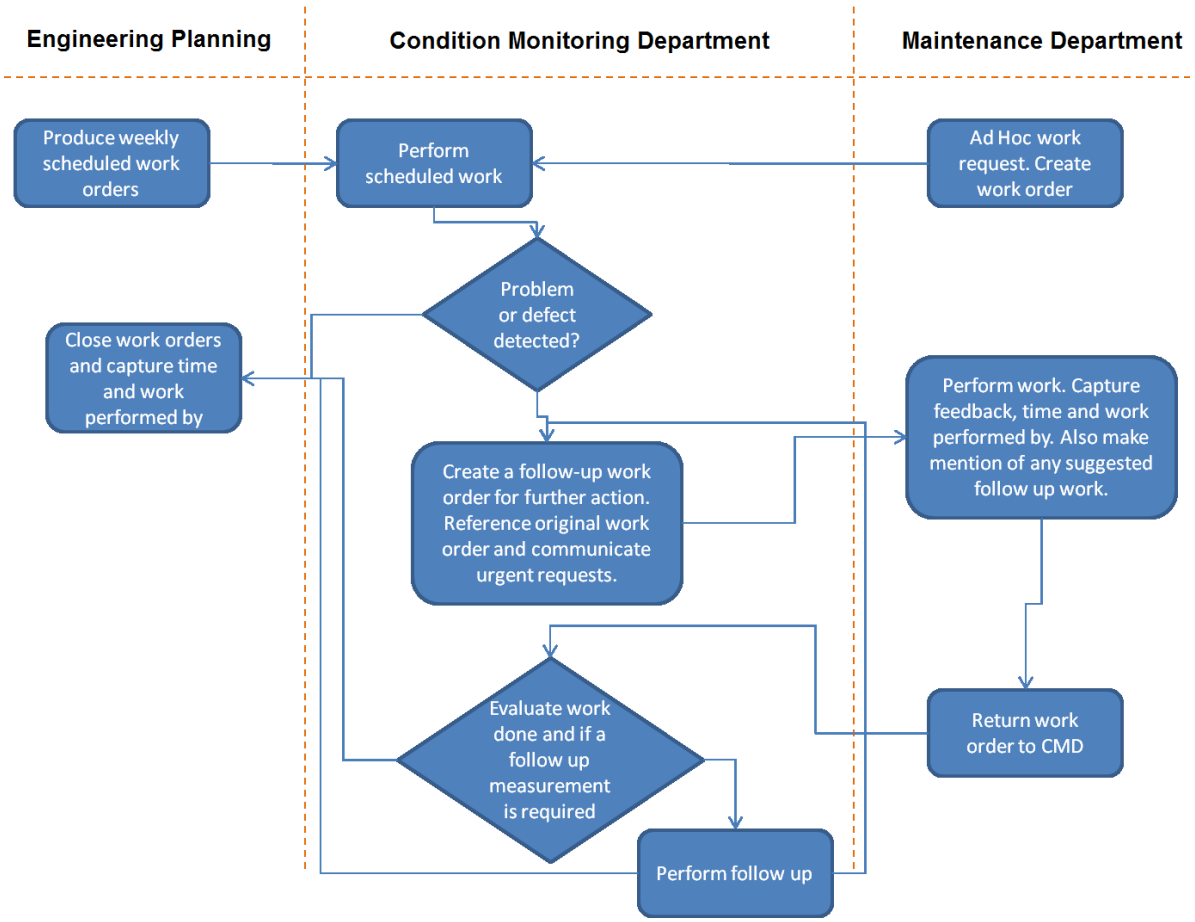


Figure A.11: CMD Work Flow Diagram (AAAMM (2013))

Maintenance Strategies using Condition Monitoring Key to the strategy for improved equipment reliability is the condition based maintenance programme that aids in the maintenance response to degrading conditions, not just a time based and intrusive programme that could well introduce degraded conditions by "fixing what is not broken".

This introduces the need to determine the conditions that actually drive the need to do some corrective maintenance by optimizing the programmes used by maintenance.

- Plant Maintenance Optimization To optimize maintenance it is important not only to examine the maintenance processes, but also the management approach, work culture, skill set, motivation of the work force, and the effective use of the technologies. Therefore, Plant Maintenance Optimization (PMO) is a programme to create a work environment that optimizes the use of resources, maintenance processes, employee skills, and technology for the purpose of meeting the maintenance objectives.

- Management and business culture Creating a positive work environment that promotes a learning organization optimizes plant maintenance. This is accomplished by: setting goals; providing strong leadership; promoting good communication; establishing an organization where individuals know their roles and responsibilities and are held accountable; and, providing the means to learn from the staff's experiences. Metrics are tracked for the purpose of understanding the areas where improvement opportunities exist and are corrected.

- Maintenance processes Using the industry's best maintenance practices to minimize the impact on production and to maximize the workforce utilization, optimizes plant maintenance. This is accomplished by identifying work at the right time so it can be prioritized, planned, scheduled, and performed. Work is documented and reviewed to learn from the experience. These processes include day-to-day work, both planned and unplanned outage work and work resulting from proactive activities such as engineering projects.

- People Skills/ Work Culture Plant maintenance is optimized by developing a highly motivated, qualified and skilled workforce, and a safe work environment. This is accomplished by providing an effective training and qualification programme, and by implementing a human performance initiative that stresses positive behaviours and values.

- Technologies Plant maintenance is optimized by utilizing cost effective technologies that maximize maintenance process efficiencies, provides timely information on equipment condition, and captures the lessons learned. Integration technologies are incorporated that allow access to multiple department data sources, and allow the findings, recommendations, and corrective actions to be shared.

- Typical Programme containing Condition Monitoring A condition-based maintenance programme that consists of information on plant maintenance strategies,

predictive maintenance applications, certification, and results reporting are best described in plant programme documents. Structured programmes are more predictable in their value output, easier to project budget needs, control expenditures on technology, and to ensure the workforce is well qualified.

Figure A.12 shows the overall maintenance strategy including the supporting programmes. Broadly, the strategy consists of preventive and corrective maintenance programmes.

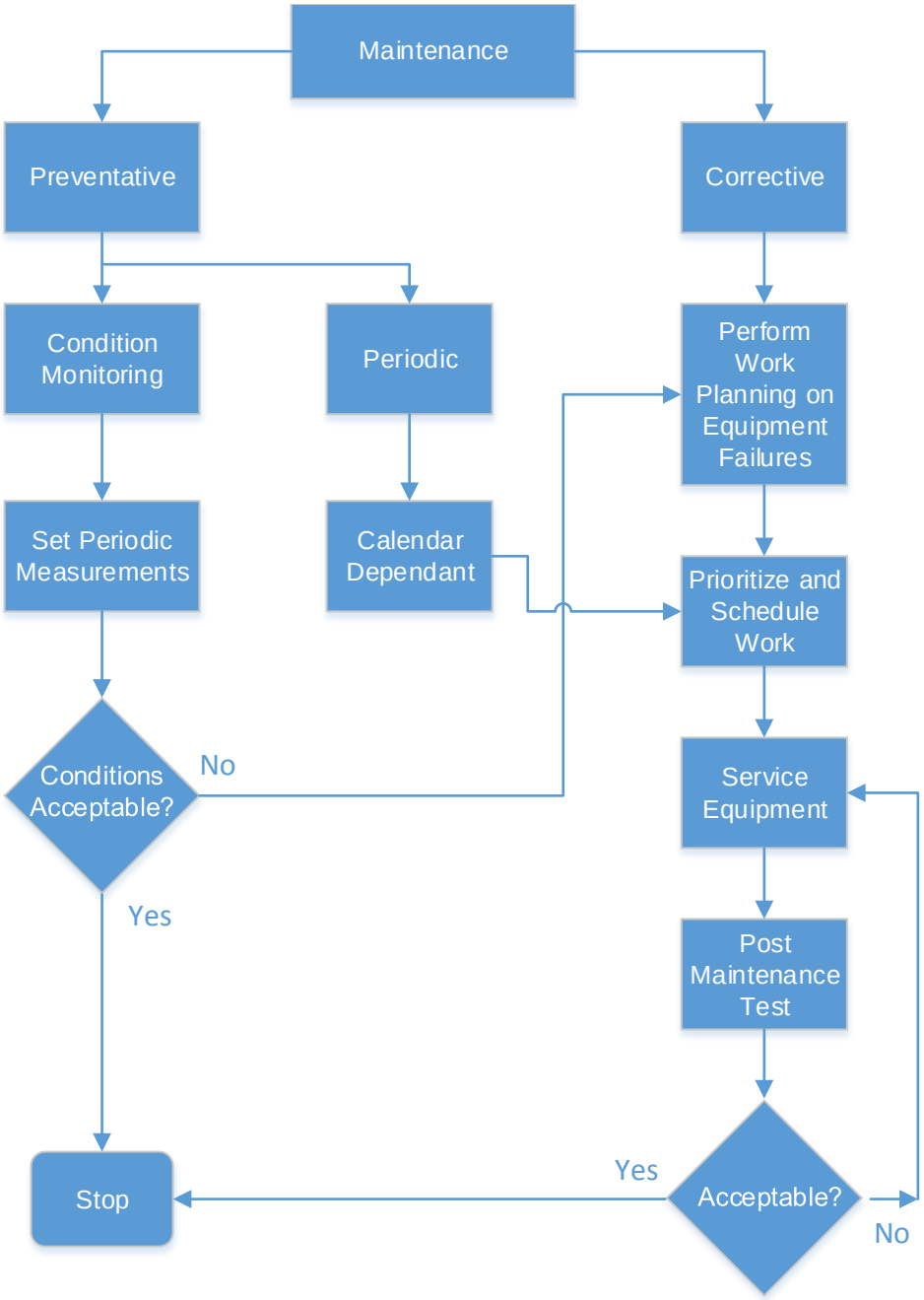


Figure A.12: Maintenance Strategy Work Flow (AAAMM (2013))

CM Policy Each operation will have a documented Condition Monitoring policy that outlines their approach to CM. This policy outlines at least the following:

1. KPIs used to measure CM performance and value ad;
2. KPIs and methods used to measure the progress of follow up work;

3. Roles and Responsibilities, CMD staff along with that off the maintenance staff;
4. Processes that apply;
5. Methods employed for CM at the operation; and
6. Reporting standards and frequencies.

This policy also supports the Maintenance Management Strategy, serves as a guideline for all CM activities, drives behaviour and is communicated to all concerned.

- Develop a ABC Concentrator specific CM strategy and policy that is supported and aligned to the DE strategy;
- Key to this strategy is the development of a condition based maintenance programme that aids in the maintenance response to degrading conditions, not just a time based and intrusive programme that could well introduce degraded conditions by "fixing what is not broken"; and
- In the event the management team considers the formation of CoE's (see Section A.4.2 CM could become a typical CoE;
- Instil an organizational culture that is characterised by staff that understands the importance of physical assets conditioning.

Conclusion In line with the Recommendation Framework it is important to during this phase take cognisance of both the Organizational Design as well as the availability of skills (Human Asset Register). Choosing a specific maintenance tactic in the absence of relevant skills or if the organization design will not support the execution of such a tactic will be futile and will lead to failure and frustration.

A.8.2.4 Task Detail Development

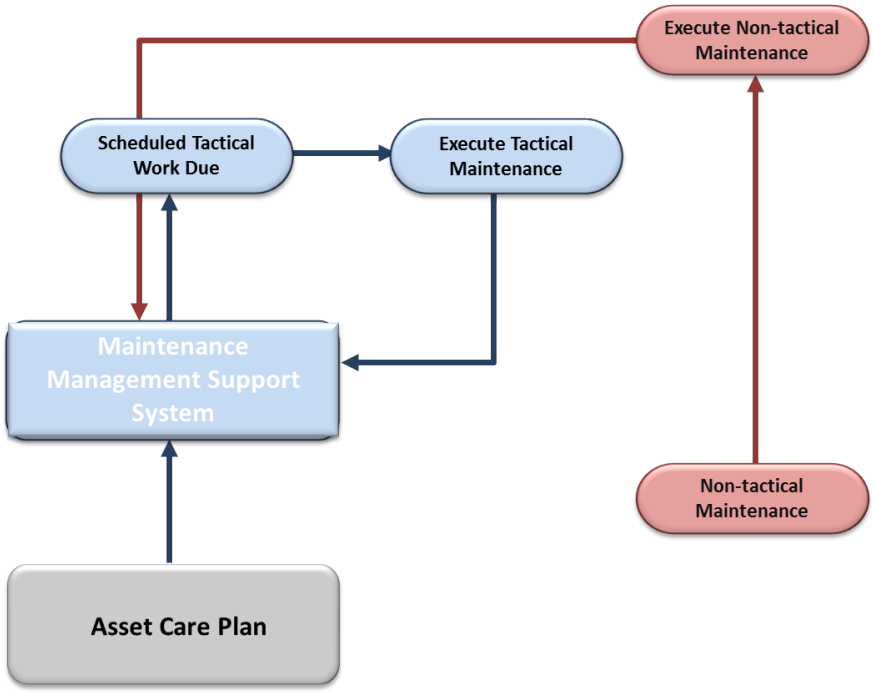
After selection of a relevant maintenance tactic the PAM team should develop a detailed plan to ensure effective implementation of the maintenance tactic. During this phase responsibility should be assigned to specific stakeholders and the terms of engagement (including relevant control mechanism) should be clearly established and communicated.

A.8.2.5 Task Implementation

Figure A.13 illustrates the Task Implementation process followed by immature organizations or organizations that finds themselves in asset management survival mode.

Figure A.14 however illustrates an optimized Task implementation process. Every every effort should be made to ensure that the organization adopts this model as a matter of course.

Figure A.13: Task Implementation and Control: Survival Mode

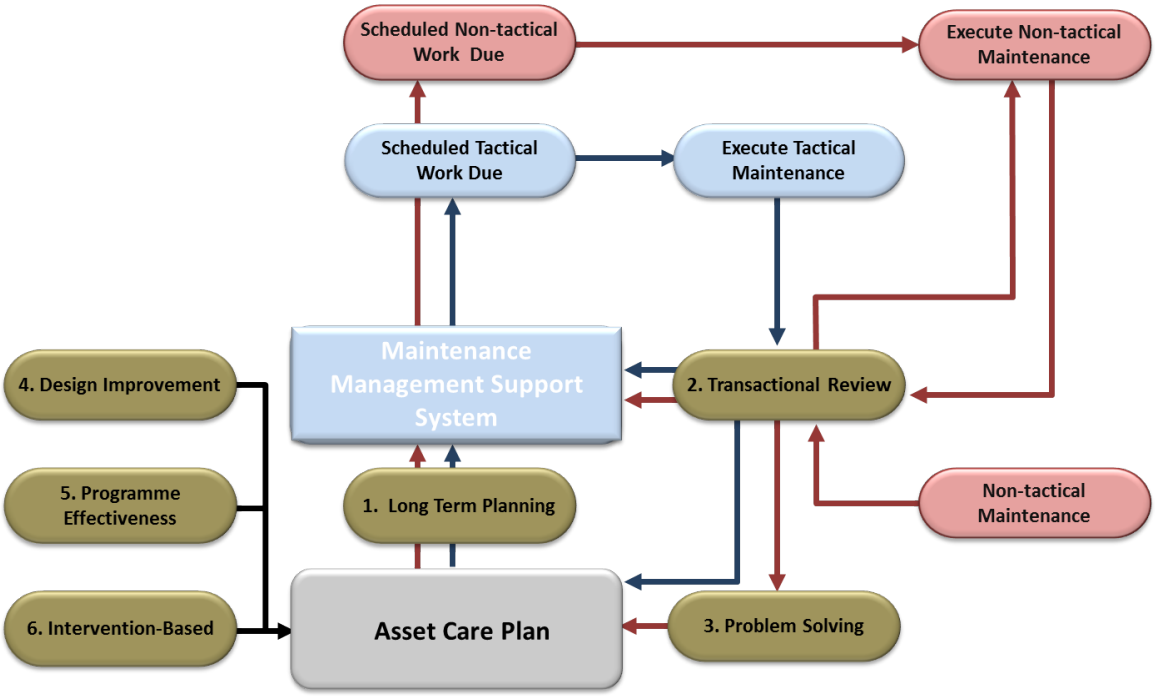


A.8.3 Organizational Design Optimization

In order to optimize the current organization design the following recommendations are made:

- Evaluate the communication and network dynamics between the operational and engineering teams in far more detail. This could be done through a Social Network Analysis (SNA). A detailed discussion of this recommendations falls outside the scope of this report; and
- Investigate the implementation of Agile organization design principles including the establishment of Centers of Excellence (CoE's) and multi-disciplinary SWAT teams. Practically this could imply that the current Engineering management becomes responsible for the establishment of PAM strategy and standards through the CoE's , while the Plant Manager through the Section engineers are responsible for the execution of the strategy. A detailed discussion of this recommendation falls outside the scope of this report.

Figure A.14: Task Implementation and Control: Optimization Mode



A.8.4 Staff Engagement

Staff Engagement is an extremely complex construct and it is important to note that there are no quick fixes. In the light of our understanding of the ABC Concentrator context we are of the opinion that the following possible interventions might assist management improve the current status quo. Recommendations one and two mainly involves analysis while element three requires a focus on execution.

A.8.4.1 Staff Engagement survey

- Conduct a detailed engagement survey to define the real nature and extent of staff engagement;

A.8.4.2 Development of an agile Human Asset base

The existing Engineering competencies and capabilities are very important drivers of short-term performance. Long–term performance and value is however created once the organization has the ability to easily adapt to changing circumstances. The primary value-creating capabilities in this regard are thus the ability to change and learn. These capabilities will enable the organization to achieve it's current objectives, but will more

importantly assist the organization to deliver on future strategic objectives. An agile organization must effectively balance and trade off resource allocations for present performance against investments that will create future fitness.

As noted above this trade-off is very evident wihtin the ABC Engineering context, where managers are constantly faced with "make–rent–or–buy" decisions when it comes to the acquisition of critical human resources. On the one hand the organizations internalize employment and build the employee skill base through training and development initiatives. On the other, the immediate crises are seemingly sometimes so big or complex that a decision is made to externalize employment by outsourcing certain functions to OEM agents or temporary staff.

In order to develop an agile Engineering Human Asset base it is strongly recommended that the organization:

- Develop an engineering competency matrix (Statement of Need (SoN));
- Develop a Human Asset Register (HAR) (Statement of Capability (SoC));
- Compile a competency gap analysis to determine exact nature and extent alignment or misalignment between the SoN and SoC;
- Investigate methods to enhance and formalize Organizational Learning and Knowledge Management; and

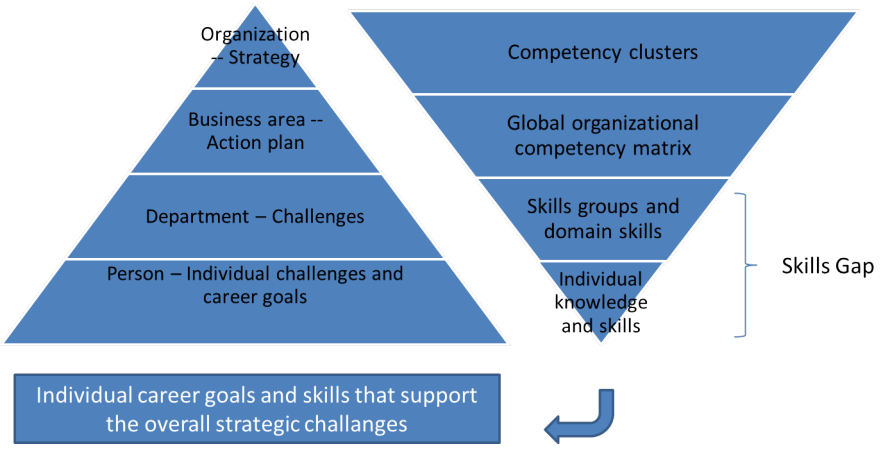
Figure A.15 illustrates how the organizational Strategy Maps to organizational competencies. The overall strategy is supported by a set of business areas with individual targets and action plans, which are again supported by organizational units and individuals organized within these units. In parallel, the strategy defines a cluster or clusters of competencies that are necessary for implementing the strategy. This is then broken down into global organizational competencies, skills groups and skills domains, and finally into the skills and knowledge mastered by the individual. The gap between the skills groups and skills domains and the sum of skills and knowledge mastered by the individuals within the organization is referred to as the skills gap.

The development of engineering competency matrix The Agile Organization design principles suggests a variance in complexity for different job levels. Decisions taken by incumbents in higher organizational strata typically involves higher levels of complexity and requires incumbents in these positions to exhibit higher levels of tolerance for complexity.

The development of an engineering competency matrix would typically involve the following steps:

- Confirmation of the existing engineering strategy objectives;

Figure A.15: Strategy driven competency mapping



- Confirmation of the current engineering processes and workflow;
- Confirmation that the definition and content of current role profiles are relevant;
- Definition of technical competency library;
- Definition of behavioural/leadership competency library;
- Development of technical and behavioural competency matrix;

A detailed description of the content of a typical engineering competency library falls outside the scope of this report.

The development of a Human Asset Register (HAR) Huge time and effort is currently spent on updating the Physical Asset register. Without such an updated register asset management planning and maintenance is severely compromised.

In the same way and within the context of the existing skills and competency challenges a HAR should be developed for the ABC Concentrator. The HAR should typically reflect the following details:

- The technical knowledge and skills of staff (both explicit and tacit);
- The behavioural knowledge and skills of staff (both explicit and tacit);
- The leadership skills and potential of staff with specific reference to the work done by **?** and discussed in detail in Section **??**; and
- The engagement levels of staff.

There are a variety of ways and means to evaluate the existing technical, behavioural skills as well as leadership and management potential. The development of a battery of assessment instruments is an essential step in the determination of the SoC.

It should be noted that the HAR is a dynamic document and should be updated on a regular basis. The HAR should form the basis of not only organizational Human Asset capacity planning, but should also inform the organizational talent management and development plan.

Develop a Competency Gap Analysis and detailed development plan The Competency Gap Analysis should provide insight into the exact nature and extent of misalignment between SoN and SoC. Once this insight a is gained the organizational can start to systematically close the gap.

A.8.4.3 Communication Campaign

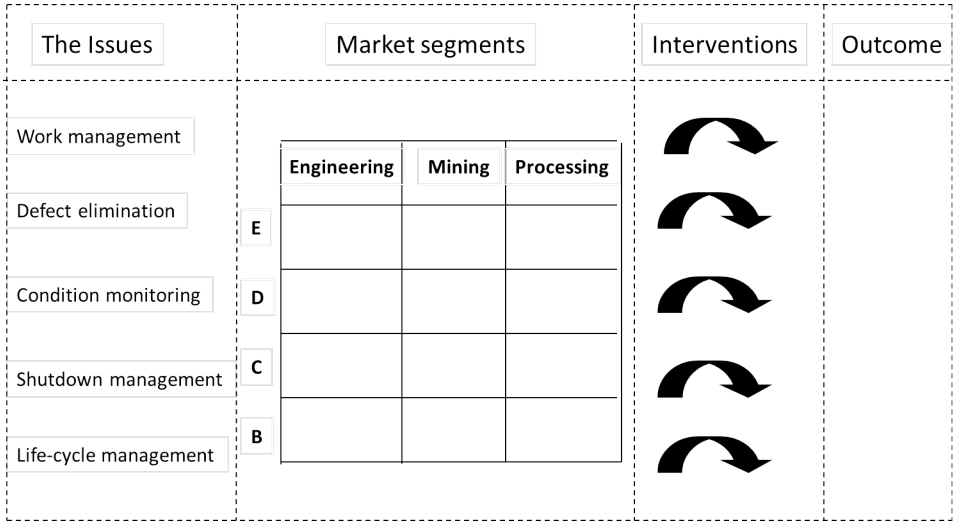
> *"Transformation is impossible unless people are willing to help, often to the point of making short term sacrifices. Employees will not make sacrifices, even if they are unhappy with the status quo, unless they believe that useful change is possible. Without credible communication and a lot of it, the hearts and minds of the troops are never captured"*
>
> Kotter (1995)

Kotter (1995) went on to suggest that companies typically devote only a minuscule share of their formal internal communication (newsletters, brochures and Intranet sites) to organizational strategy. The contention of most academics and communication practitioners is that strategic communication should increasingly become the focus of internal communication efforts. To perform organizations need the fully aligned, principled, inspired, collaborative and discretionary effort of employees. Organizations can only get this through a continuing process of communication on leadership's vision and values. The communication process builds awareness, understanding, acceptance and commitment to strategic intent.

To ensure that strategic leadership communication really happens, the organization should move away from the so-called *contentment* model of workplace communication to a *commitment* model of communication. Under the contentment model, the objective is to increase employee satisfaction and morale or contentment. Under the commitment model, the organizations vision is central to all communication efforts. It's objective is to facilitate the execution of strategy, bring about change, and help achieve business goals.

It is however important to note that even when the formal communication media in the organization supports the strategy the transformation process still faces long odds against success unless and until it brings its semi-formal and informal communications in line with its strategic intent.

Figure A.16: Typical communication campaign format



As indicated in Section A.4.3 the flow of communication among the participants to the investigation seem to be in general top-down and with a very strong focus on safety and very limited focus on any other strategic Asset Management objectives. This is specifically noteworthy when this observation is compared to findings made in similar studies within other environments. Non-effective communication is often the Achilles heal of most organizations and an important strategy execution barrier.

It should be noted that the project team did however not investigate the nature and extent of communication practices in detail. During the superficial investigation no reference was however made to the existence a well defined communication strategy or campaign. The organization also seem to rely mainly on formal communication media (such as mass meetings, and team planning and briefing sessions).

These formal media forms typically account for only a small share of workplace communication. Most communication by far is semi-formal or informal communication, which many line managers and even communication practitioners mistakenly fail to regard as real communication. Ironically, semi-formal and informal communication is often more strategic, more powerful, more contextual, and more credible than a companies formal communication. But because it is typically no regarded by management as deliberate communication (at least not as official communication) semi-formal and informal communication is often left to work against the organizations formal communication. Indeed it has the potential to corrode employee perceptions of the organizations strategic intent.

It is thus strongly recommended a concerted effort is required to develop an integrated internal communication campaign. The typical structure of such a campaign is illustrated in Figure A.16.

In the development of such a campaign the following principles should be considered specifically:

- **Clarify the issues** – Clarification of issues is a function of strategic planning, and the general rules regarding the importance of focus applies;
- **Know the market** – In the same way external marketing campaigns would be ineffective without a proper understanding of the various market segments, the development of an internal communication campaign required a thorough understanding of the "market segments". The internal market should typically be segmented in terms of the following criteria:
  - Demography – sex, age, gender, race, education, language etc.;
  - Grading; and
  - Psycho-graphically – values, ideals, motivating triggers, needs, fears and aspirations.
- **Target the message** – targeted organizational communication typically has the following characteristics:
  - Consistent over a period of time;
  - Relevant to the target audience;
  - Creative which enhances likeability and memorability;
  - Coherent with a creative "golden thread" that permeate all communication opportunities; and Measurable in the sense that the perceptions created by the communication message should be tracked and evaluated over time.
- Maximize the media – Ensure that the use of relevant communication media (formal, semi-formal and informal) are aligned to the achievement of the communication objectives.

A.8.4.4 Management style

As indicated in Section A.7 relatively strong evidence of a top-down and non-participative management style was observed. This is particularly concerning especially if the advantages of a more participate management style is considered. The advantages of such a management style is well documented and include:

- **Increase in productivity** – An increased say in decision making means that there is a strong feeling of association. The employee now assumes responsibility and takes charges. Working hours for example may get stretched on their own without any compulsion or force from the management. All this leads to increased productivity;

- **Increased job jatisfaction** – In organizations that employ participative management, most of the employees are satisfied with their jobs and the level of satisfaction is very high. This is especially true when people see their suggestions and recommendations being implemented or put to practice. Psychologically, this tells the individual employee that, he or she too has a say in decision making and that he or she is an integral component of the organization and not a mere worker;

- **Motivation** – Increased productivity and job satisfaction cannot exist unless there is a high level of motivation in the employee. The contrary is however also true. Decentralized decision making means that everyone has a say and everyone is important;

- **Improved quality** – Since the inputs or feedback comes from people who are part of the processes at the lowest or execution level. This means that even the minutest details are taken care of and reported. No flaw or loophole goes unreported. Quality control thus begins and is ensured at the lowest level.

- **Reduced costs** – There is a lesser need of supervision and more emphasis is laid on widening of skills, self management. This and quality control means that the costs are controlled automatically.

It is however important to also caution against the fact that it the following disadvantages of the participative management style:

- **Decision making slows down** – Participative management stands for increased participation and when there are many people involved in decision making, the process definitely slows down. Inputs and feedback starts pouring from each side. It takes time to verify the accuracy of measurements which means that decision making will be slowed down; and

- **Abdication of responsibility** – Participative management can sometimes (especially in less mature environment) be interpreted as the abdication of responsibility.

In the light of the overwhelming advantages of the particular management style it is however strongly recommended that the style is cultivated as part of ongoing leadership development within the organization.

A.8.5 General Recommendations

In addition to the above recommendations that forms part of the Recommendations Framework the project team includes the following additional detail. Within the context of scares resources the project team is however of the opinion that the recommendations included in the Framework A.8 should demand the highest priority attention.

A.8.5.1 Work Management

Call-outs, Overtime and Engineering staff on back shifts The general feeling around the plant is that the number of call-outs is a major problem. This is particularly pronounced on the night shifts. Production spend their night shifts phoning supervisors to ask for permission to call an artisan out to repair a piece of equipment. Generally the callout is made because of a breakdown. The plant then stands still with zero production until the Engineer makes it to the plant and fixes the problem, which could take hours. This whole process is costing the plant a lot of money, due to the high costs of callout work and the loss in production for the time the plant is off-line. Not having an Engineer/artisan on site during afternoon, night and weekend shifts is also causing the culture of allowing an asset to fail before it is repaired, as callouts aren't typically made unless the problem results in a breakdown.

The recommendation is to have an Engineer on back shift on the plant during the afternoon, night and weekend shifts. This Engineer would need to have a brief background across most fields of Engineering or at least have knowledge thereof (mill right). This would not only decrease the number of callouts but would help decrease the number of breakdowns and promote preventative maintenance rather than reactive maintenance. Production would also be more consistent, as the plant wouldn't be off-line so often.

It was also noted that safety adherence on the night shifts is poor due to the fact that a safety officer is not on shift. Although there are safety reps on the night shifts, these people have other primary jobs and safety is merely a side job. Many people feel that a safety officer is necessary to check up on safety adherence and to ensure a safe working environment.

Optimize Existing Job Card Protocols Work management is defined as techniques applied to the organization and conduct of work for purposes of maintaining efficiency or effecting improvement. Work Management, however, is more an operational method than a tool that can be applied to address a problem.

Job cards are used to keep record of the work done on the plant and the work that is still outstanding. In terms of creating and closing job cards on SAP, the system is efficient, however there are some inefficiencies with regard to follow-through and feedback. There are instances where operators create a job card for a specific Engineer, yet the task actually requires an Engineer from a different department. This job card is then either disposed of or forgotten thereby leaving the job unattended to, without any communication as to why. Another example of poor follow through is the lack of inspections after the job is completed. Although the Foreman is required to sign off on the job once it's been done by the artisan, there are many instances where this happens without inspection of the work. Lastly there are problems with regards to how complete the job cards are; there are many instances where the artisan hands in an incomplete job card.

Feedback The feedback aspect of Work Management clearly needs to be improved upon, therefore it is recommended to create a proper feedback system with regards to job cards. The feedback system explained below is adapted from the Anglo American Asset Management Manual. Feedback on completed work is required mainly for two reasons:

- Accurate "history" information is an essential input into reliability engineering and improvement processes; and
- Knowledge of the current state of completed and outstanding work to assist with daily allocation and weekly scheduling.

It is important that work order feedback is properly used for the purposes listed above. In order to satisfy these two issues, the following feedback is typically required in a job card:

- All personnel who performed work related to the work order;
- Labour hours of each person and some explanation if the variance from an estimate is greater or less than 20%;
- The actual work performed, as well as possible follow-up work that still must be planned and scheduled;
- Details of the failure (through the failure codes if activated on un-programmed work orders);
- Actual quantities of parts used and report stock numbers if not provided on the work order;
- Actual special tools used or made if not provided on the work order;
- Updated drawings reflecting any changes made;
- Any changes to equipment technical information such as new serial numbers and model numbers and names; and
- Include any other information such as bearing clearances (radial and thrust), wear ring clearance, shaft run-out clearance, bearing to cap clearances, coupling condition and gap clearance.
- Any recommendations to help future tasks.

This feedback will greatly help with "filling in the little details" that one usually requires for a complete assessment / report on work completed. Ideally these job cards should be completed, analyzed and captured in SAP within 24 hours after work completion.

Ensuring Quality Feedback The Foreman is responsible for ensuring that quality feedback on completed job cards is obtained from the Artisans. If the planning function receives job cards with incomplete information, it must simply be returned to the Foreman (and not directly to the artisan or contractor). It is very important that a strong focus is placed on quality feedback, otherwise the Artisans or Contractors will try to provide as little as possible information. To achieve this, the Foreman can review a random number of completed job cards during his morning meeting with the work group. By simply asking questions and discussing the feedback on a small number of job cards, the Artisans and Contractors will start to co-operate. Most often Artisans provide the best feedback on an on-going basis if they see that feedback provided is read and appropriately acted upon.

The Foreman should also ensure that any job cards that are incorrectly issued should be given back to the creator of the job card with the reason as to why he/she cannot complete the job. This should be done in order to close the loop and inform the creator that the work still needs to be done.

Feedback Analysis Feedback recorded on returned job cards must be reviewed and analyzed before being signed off and closed on SAP. While the purpose of reports is to analyze trends across numerous job cards, this activity is all about reviewing the information on a single job card and taking appropriate actions from a continuous improvement perspective.

Feedback analysis is one of the most important activities of the Work Management process as it ensures more efficient planning of future maintenance tasks. A good co-operation between Foreman and planner regarding the analysis of feedback is normally evident at operations that are successful with work management. The Foreman will often check for specific triggers such as identifying follow-up work, while the planner will look for opportunities where master data must be changed. There might not be a hard and fast rule, but what is important is that all feedback information is appropriately addressed. One of the main reasons why Artisans often do not provide feedback is the impression they have that nobody reads or acts on their feedback. A huge effort must be made to change this impression.

Listed below are typical actions triggered through analysing the feedback.

- Raise follow-up;
- Updating of drawings;
- Changes to equipment register;
- Changes to spares list;
- Changes to maintenance tasks;

- Addition of maintenance tasks; and
- Changes to long term plan or schedule.

The Forman's Role The Foreman plays an extremely important role for ensuring correct Work Management Procedures. Overall the Foreman is responsible for coordinating, control communicating and ensuring that the section's targets are met, which can be seen by their list of typical Work Management responsibilities below;

- Ensuring Work Management performance measures in his/her section are met;
- Assigning Artisans to specific tasks and supplying the work order packages to them;
- Scheduling and coordinating daily and weekly work in his/her section;
- Ensuring job card integrity and the upgrade of any deviations;
- Creating the draft standard work procedure documents.

A.8.5.2 Develop Shutdown Optimization Plan

Plant Shutdown is the period of time during which major assets or the entire plant is taken off-line. Shutdown is primarily done to complete maintenance work that is difficult or impossible to perform while the plant is running. This is one of the most resource intensive activities a company can undertake due to the complex planning and scheduling that is required. This plant encounters a Shutdown once a month for 48 hours, however this activity is not yet fully optimized yet, due to the poor planning. This plant still struggles with starting the plant on time after a Shutdown due to a variety of problems, which are listed below;

- Not having the correct documentation and permits prior to the Shutdown
- Not procuring the correct tools before Shutdown
- Not having a specific schedule

In order to optimize the Shutdown i.e. adhere to the safety standards, perform all the maintenance activities required and keep the downtime to a minimum, the planning and scheduling stages needs to be effective. All of the processes that are performed during a Shutdown need to be repeatable, sustainable, and continuously improved.

Shutdown Management is a special kind of project management where the planning is done while the plant is on-line, therefore some faults might only be picked up on once the plant is shutdown and inspected. This makes it difficult to plan the scope of the project,

regarding cost, resources and duration. The following stages of Shutdown Management is listed in the Anglo American Asset Management Manual.

It is important to note that these are merely guidelines and there are no hard and fast rules, as all plants differ and have their unique operations. The six stages in Shutdown Management are as follows;

1. Define;
2. Plan;
3. Schedule;
4. Execute;
5. Complete; and
6. Analyze.

If the definition, planning and scheduling steps are done poorly, the Shutdown will be unsuccessful.

- Definition Stage – This section is designed for reviewing the key activities driving the Shutdown. This could include equipment maintenance or capital upgrades. The context and boundaries of the Shutdown should be defined, which include;
  - Scope of the critical tasks for the Shutdown;
  - Constraints: time, budget, resources, etc;
  - Key stakeholders that will have to be involved early (particularly Contractors and suppliers);
  - Key approvals that may be required through the investment committee;
  - Key metrics to set a baseline for improvement. These may be different for one off shuts compared to sequential shuts. Common measures include percentage completion, injuries per man hours, timing (% over or under), variance to schedule, resource utilisation etc;
  - Shutdown management strategy and reporting relationships; and
  - Is this a single event or a sequential activity? A more defined process can be established for repeatability in a sequential activity (For example, 6 weekly routine shuts).
- Shutdown Team – A team should be appointed to plan, control and manage a shutdown, who are fully responsible for the 6 stages listed above. This team should be led by a Shutdown Manager. This team should be divided between a planning and a coordination team.

The purpose of the Shutdown Planning Team is to provide a centralised planning function to deliver quality plans and ensure an adequate supply of competent labour resources for all Shutdown activities. The Shutdown Planning Team develops a detailed and comprehensive plan for the execution of the agreed scope of work. This includes the development and preparation of work packs, Gantt charts, contracts and execution plans. The Shutdown Planning Team will support and assist the site Steering Committee to develop a scope and budget for the Shutdown and guide and assist the Task Owners in the planning of their activities and ensuring that the SMP is followed.

The Shutdown Coordination Team is responsible for ensuring that the Shutdown is completed within the context and boundaries, as defined in the Plan and work packages generated by the Shutdown Planning Team. The team will report through to a Shutdown Coordinator and lead the implementation stages, control the execution, participate in the review stage, and facilitate the knowledge management process. The size and complexity of the Shutdown will govern the number of resources required for the Shutdown Coordination Team and whether or not their involvement will be full time. Ideally the team members will be removed from their normal roles, and appointed to the team full time, for significant Shutdowns. The appointment of the team should take place with sufficient time prior to the Shutdown to allow adequate preparation.

Planning Stage The planning process is critical and includes preparing how the work will be done, what resources will be required, the communication process and clear responsibilities. The following figure depicts the Shutdown Planning Process adapted from the Anglo American Asset Management Manual.

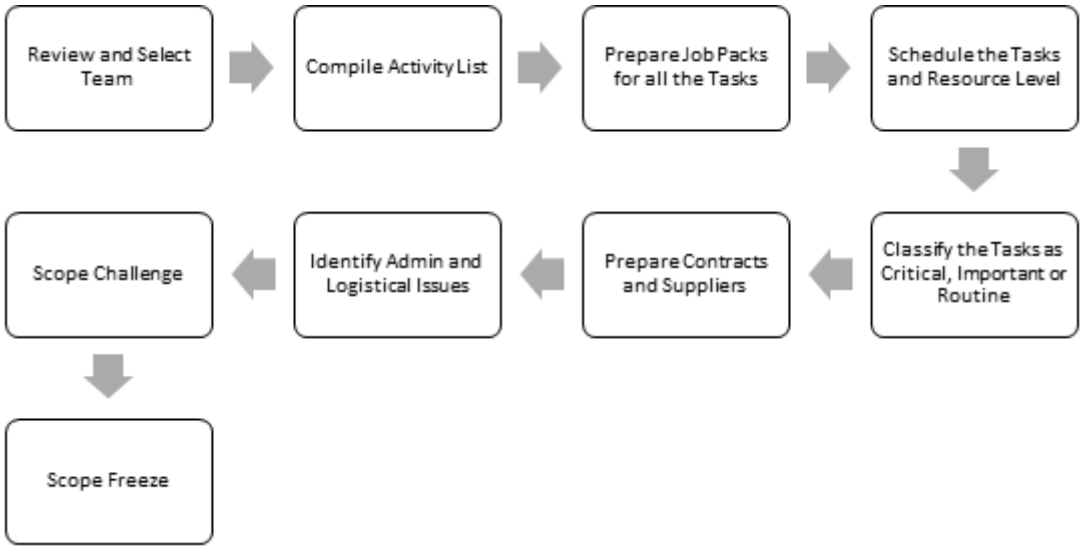


Figure A.17: Shutdown Planning Process

- Review and Select Shutdown Team This team is appointed to manage the preparation work that is required for all the maintenance activities during the Shutdown.
- Compile Activity List The list of the proposed activities should be drawn from:
  - Maintenance schedules;
  - Condition monitoring reports;
  - Corrective work; and
  - Key operational and maintenance stakeholders

  The estimated cost, duration and labour requirements should also be captured during the planning process.
- Prepare the Job Packs – Each task on the schedule will have to have a job pack that the Shutdown Planning Team are responsible for. The people doing the work, including any Contractors should also be involved in this process. This job pack includes all the necessary documentation that will be necessary to perform the tasks.
- Classify the Tasks – A meeting should be held with the relevant stakeholders to assign classifications for each task. The tasks should be classified based on the definitions of critical, important and routine.
- Tender Contract Activities – The tender periods need to allow adequate time for preparation and appointments of any Contractors.
- Appoint Contractors – These tenders should be assessed by the Shutdown Team and the successful Contractors should be notified and informed of their involvement from the preparation phase right through to execution.
- Administration Issues – The administration issues should be handled by the Shutdown Planning Team, which may include transport, supplies, PPE, inductions and permits.
- Scope Challenge – Subject matter experts from related disciplines will analyze each work scope item to identify the primary Shutdown drivers.
- Scope Freeze – The Shutdown Planning Manager will lock down the work scope, meaning that no additional work will be accepted for inclusion into the schedule. The Shutdown Manager may however authorise any additional work once the Shutdown has happened.

Scheduling Stage – This Scheduling stage is the most important in the management of the Shutdown. It involves planning and scheduling the activities to produce the final Shutdown schedule, refinement of the budget estimate down to +/- 10%, auditing the preparation tasks, and conducting a broad level SHEC review. The Scheduling stage is accompanied by an implementation process, shown in the figure below.

Figure A.18: Shutdown Scheduling Process

- Finalize Job Packs – The activity list should be finalised to ensure that there has been adequate planning and preparation of the tasks in order for them to be completed safely, on time and to an acceptable quality.
- Develop Major Shutdown Budget Estimate – The budget structure and the amount allocated in the plan should be reviewed with the relevant Superintendents.
- Develop Physical Resource Schedules – The schedule is critical for the Shutdown to run as planned. The resources should be assigned correctly to each task for the schedule to be successful.
- Develop Physical Resource Schedules – The Shutdown SHEC Coordinator must facilitate a broad SHEC risk assessment. The risk assessment should identify issues such as, management of required Work Permits (Confined Space, Hot Work, etc.), Inductions, SHEC Audits, pre task risk assessments and nominate how they are to be managed. This plan should take the proposed activity list and estimated number of personnel into account. The outcome from the risk assessment should be a review of existing controls for the impacts and the further controls required before and during the Shutdown to lower the risk to an acceptable level. The risk assessment should be reviewed and then signed off by the senior management accountable for the area.
- Develop the Contingency Plans – In addition to the SHEC risk assessment, the activity list and draft schedule for the Shutdown should be reviewed to identify tasks that are high risk to the successful outcome of the Shutdown. Appropriate

contingency plans should be established and documented to manage the risk of these tasks and to ensure that good decisions are made during the Shutdown.

- Identify Induction Requirements – Once the required workgroups have been identified by the Shutdown Team, an induction plan can be developed. The inductions should contain information specific to the Shutdown as the workplace and associated hazards can differ dramatically from when it is operating. Inductions may also be required for internal personnel coming from different areas of the plant or different sites. Additional briefings may also be required for larger tasks where Contractors can be bought to site before the Shutdown. Access control at the gates should also be organized and streamline to prevent delays.

- Sign off Master Shutdown Schedule and Budget – All revised activity schedules should be incorporated in the master schedule. The master schedule should then be reviewed by the Shutdown Coordination Team to ensure optimal sequencing of activities. The schedule should now also include all resources, physical requirements, scaffold, cranes, light vehicles, tooling etc., which should be checked to ensure no over or under allocations exist. The master schedule should also include the commissioning processes both in ramp down and ramp up stages. The overall Shutdown budget should also be revised.

Execution Stage During the Execution stage of the Shutdown, the focus shifts from Planning and Scheduling to Monitoring and Control.

Figure A.19: Shutdown Execution Process

- Shift Handover and Communication – It is critical that all teams communicate relevant information at the start and finish of each shift. This information will include all incidents, team issues and concerns to be handed over to the oncoming shift, specific SHEC actions and issues, daily progress against schedule, a review of tasks progress and expectations for the shift, and further items that require action during the shift arising from these issues. The Shutdown Supervisor will be

responsible for facilitating the shift handover. The incoming and outgoing teams should both be present at the handover.

- Daily Review Meetings – The Shutdown Coordination Team will meet daily to review the progress of the Shutdown. The team will review any SHEC issues from the previous day and specific issues for focus moving forward. The supervisors are responsible for providing the team with an update of each task and this will be updated by the Shutdown Planning Team to produce an updated schedule. Any critical issues will be raised at this session and an action plan put in place to manage these. An output of the meeting will be a rolling action plan that will detail the preventative actions in place to mitigate any threats to the schedule or SHEC issues.

- Monitoring of Schedule Performance – At the Daily Update and Review Meetings the progress of the schedule will be tabulated for review. It is critical that the shift supervisor have accurate updates of tasks as this information will be updated on the schedule. Before the Daily Review meeting, the Shutdown Planning Team will prepare a tracking Gantt chart or use any other visual means, showing the progress of tasks against the schedule. The Shutdown Planning Team will also need to prepare a Critical Path Schedule based on the updated task information. This will highlight any critical issues in terms of the schedule.

- Critical Issues and Contingencies – During the Shutdown there may be issues that threaten the progress of the shut. These include, but are not limited to, major incidents, poor standards of work, critical tasks behind schedule, additional resources available due to cancellation of tasks, cranes out of service, cyclones, etc. A rolling action plan will be managed by the Shutdown Coordination Team to ensure that corrective actions are put in place to manage these issues. In some cases where critical issues are identified in the implementation stage contingency plans would have already been prepared.

- Updating the Senior Management – The Shutdown Coordinator is responsible for providing a daily update of the Shutdown progress to Senior Management. This is critical to ensure contingencies are well resourced, decisions are made at the appropriate level and higher level issues for the operation can be addressed. Senior management can provide substantial support to the Shutdown Coordinator in maintaining focus and alignment for the teams.

Completion Stage – This stage involves tying up any lose ends and making sure the plant is up and running. All relevant maintenance history is updated and any process improvements captured for analysis. All outstanding disputes are resolved, all Contractors billing is finalised and payment authorised.

Analyze Stage This stage includes the identification of improvement opportunities by using all available data and by conducting a facilitated lessons learnt workshop involving

all relevant people to ensure continuous improvement in the execution of Shutdowns. This is also the time to celebrate successes.

This stage was recently implemented at ABC Concentrators, which includes a post-Shutdown meeting to discuss any problems and successes in order to plan appropriately for future Shutdowns.

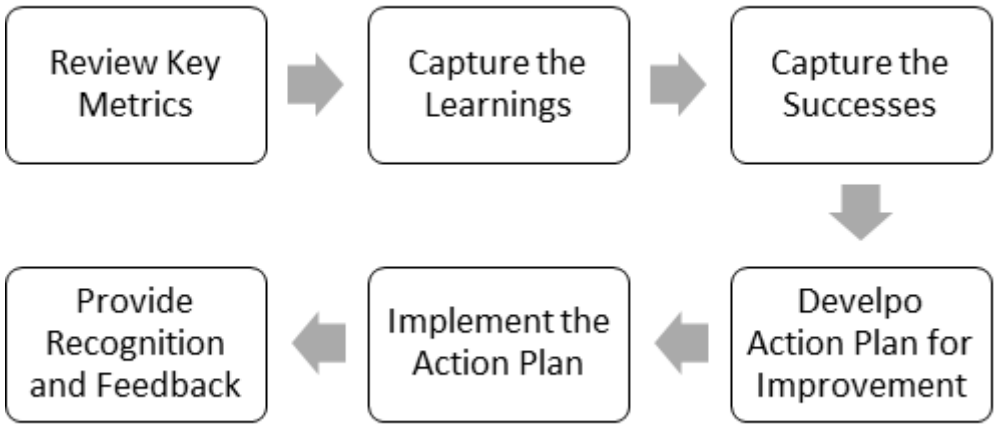


Figure A.20: Shutdown Analyze Process

- Review of Key Metrics – This is the initial step of the Review and sets the context in terms of the performance of the Shutdown against the key measures. This will give the team a high level understanding of where the key improvement areas are, and some of the areas that were successful.
- Capture the Learnings – The Shutdown Coordinator should facilitate the group in reviewing the main learning and improvement areas of the shut. All team members should contribute their views of what could be improved in future Shutdowns.
- Capture the Successes – Similarly, the team should put forward their views of what went well during the shut. This must be captured to ensure the work behind these areas is repeatable for future Shutdowns.
- Develop the Action Plan – The Shutdown Coordinator should now lead the team into selecting the key areas that can be targeted for action. The team must produce a prioritized list of actions to be completed before the next Shutdown. It is important to ensure that the actions plans are achievable in that time frame.
- Recognition and Feedback – The Review is an ideal period to provide the team with feedback on their performance and recognize the significant efforts and contributions toward the Shutdown. It is appropriate for the Shutdown Coordinator to provide

this recognition and feedback, however, it can be further endorsed by representation from Senior Management.

The team has seen first-hand how Management has praised and recognized the team after the Shutdown was executed. The team really appreciated this and it goes a long way to ensure that the team stays dedicated and committed for future Shutdowns.

A.8.5.3 Asset Financial Management

Ensure full implementation of Activity-Based Budgeting plan With the advent Activity-Based Budgets (ABB) in January 2015, ABC Concentrator has a unique challenge on its hands to ensure the success of this new venture. After looking at trends throughout the past year and setting company goals, the next step in creating a budget is to develop a budgeting process. Fashioning a budgeting process and budgeting model to be used throughout the organization is in itself a 4-step process:

1. **Develop a Budget Process Outline:** To begin developing a budget process, first create an outline. Deciding on what budgeting platform to use and what the submittal and review process should be are two keys to developing an overall budgeting process. It is also helpful to look at what level budget needs to be monitored. For example, monitoring the budget at the lowest account level will require an entirely different process than monitoring the budget at the financial statement level.

2. **Identify Budget Guidelines:** The next step in developing a budgeting process requires identifying budgeting guidelines. In identifying budgeting guidelines, it is necessary to put together an overall plan that achieves a specific percentage of revenue growth. Guidelines should include the directive of a revenue percentage growth as well as the business plan to support to attainment of the budget. Overall, the guidelines will function as the action plans, allowing an organization to adhere to their budget while achieving business goals. A budget in itself merely describes numbers, while the budgeting guidelines function as the plan of action. For example, if next year's budget reduces employee compensation by 5%, a potential guideline could be to institute a hiring freeze. Other guidelines may relate to salary change, expected changes in foreign currency expectations, fluctuation in labour costs, and outsourcing costs.

3. **Identifying Key Budgeting Participants:** The next step in developing a budgeting process is to identify the key budgeting participants, and delineating the key participants largely depends on the budgeting guidelines. The structure of the budget, whether created chiefly at the executive level, at the department level, or by every employee of the company, will determine what individuals need to be involved in the process. Finding the key participants also depends on the structure

of a company, the number of executives, the number of department heads, and the number of departments.

A related step in identifying key budgeting participants is education. Individuals that are involved in the budgeting process need to understand their role, understand the goal of the process, and be familiar with certain budgeting terminology. Key participants need to be identified so they can participate in the process, yet getting these individuals to contribute to the best of their ability is easiest when everyone understands certain basic information. If the budget process involves participants from all departments, it is likely that some participants will not have prior knowledge about finance and budgeting. Educating these individuals on budgeting procedure, as well as their role, will make the budgeting process go as smooth as possible.

4. **Determine a Time frame:** The final step in developing a budget process is to set a time frame. Ideally, the budget for the next fiscal year should be approved and take effect on January 1st. It is helpful to work backward from this day to determine the key deliverables and deadlines that need to be put in place. A GANTT chart or some schedule can be helpful, as that will outline not only who is responsible for what, but also when certain deliverables are due.

Overall, developing a budget can be a kick off to a successful new year. The budgeting process itself details the cost relationship to results and the impact this can have on an organization. In addition to constructing a solid budget, there are also other steps companies can take to make the next year as financially secure as possible. Beginning the year with good reporting tools, properly aligning the accounting system against the budget, and implementing corrective actions based on budget performance are all keys to having a successful year.

Categorize asset in terms of criticality Without circumventing the experience of Foremen, a more structure approach is needed when adjudicating the criticality of assets and subsequently setting lists of critical spares. A Criticality Analysis such as the often used Failure Modes, Effects and Criticality Analysis can be implemented to support the gut-feeling of these experienced Foremen. It takes into account asset failure severity, occurrence and detection.

Severity refers to the degree of disruption, destruction or cost associated with a particular failure mode. Plant downtime is often used for severity as it is disruptive and massively expensive event. On the other hand, occurrence signifies the frequency of a failure mode. Obviously the more frequent the failure, the more worrisome one should be. Lastly, detection implies the ability or even probability of identifying the precursors to failure before it actually happens. The more difficult it is to detect imminent failure, the harder it is to plan preventative actions (maintenance, asset replacement, etc.) prior to failure.

Failure Modes, Effects and Criticality Analysis is simple to implement and the benefits include the ability to set fact-based critical spares lists as well as enabling Foremen to spend their budgets on assets that are critical rather than luxury buys.

Implement Cost-benefit analysis Performing a cost-benefit analysis is critical for any project. It is a comparative assessment of all the benefits one expects form a project. This includes the cost to introduce the project, perform it, and support the changes resulting from it. A cost–benefit–analyzes helps with the following:

- Deciding whether to undertake a project or decide which of several projects to undertake;
- Developing an appropriate before and after measures of project success;
- Prepare estimates of the resources required to perform the project work; and
- Frame appropriate project objectives.

The implementing of cost-benefit–analyzes will assist ABC Concentrator in quantifying the losses incurred with product overflowing in the floatation section. Following a CBA, a more informed decision can be made with regards to the request for procurement of plastic piping to prevent over spilling material.

A.8.5.4 Asset Management Life Cycle

When managing the life cycle of an asset, it is important to take into account all the costs involved throughout the lifespan of the asset. Life Cycle costing looks at the total cost of having an asset.There are typically six stages on any Life Cycle Costing (LCC) Model. The first four stages comprise of the Life Cost Planning phase with the last two stages incorporating the Life Cost Analysis phase. The six stages are:

- Stage 1: Plan LCC Analysis
- Stage 2: Select/Develop LCC Model
- Stage 3: Apply LCC Model
- Stage 4: Document and Review LCC Results
- Stage 5: Prepare Life Cost Analysis
- Stage 6: Implement and Monitor Life Cost Analysis

A detailed discussion of each one of these phases falls outside the scope of this report.

A.8.6 Contractor Management

A.8.6.1 Stop fretting over current contractor situation and iron-out inefficiencies

The dominant influence of Corporate on the selection of Contractors has somewhat immobilized most plants including ABC Concentrator. However, this should not be perceived as an insurmountable obstacle. It should rather be seen as an opportunity for ABC Concentrator to streamline their contractor processes in order to iron-out any present inefficiencies. Should Corporate ever release their stronghold over contractor selection, ABC Concentrator will already be more efficient in the way they deal with their Contractors. Below are two recommendations have been mooted to achieve a more proficient contractor process.

A.8.6.2 Build rapport with Contractor

ABC Concentrator should strive to build closer relationships with their Contractors through continuous dialogue. For example, ABC Concentrator should do more than just read contractor reports regarding the upkeep of their cells in the floatation section. They should be actively involved in the process of establishing which cells are most at risk and therefore critical.

Active involvement includes discussions with Contractors prior to them commencing work. Moreover, these deliberations need to be preceded with ABC Concentrator's own assessment of the criticality of their cells. Doing this will ensure an informed debate with the Contractors, whilst keeping them on their toes. It is not to question the integrity of the contractor but rather to ensure ABC Concentrator is receiving the agreed upon level of service which they are paying for.

A.8.6.3 Actively assist Contractor

Few people can deny how demanding it is to be a Foreman. Which is why, removing mundane tasks and subsequently lessening their workloads should be explored at every given opportunity. Keeping up to date with the paperwork regarding Contractors is a time consuming and cumbersome task. Foremen get bogged down by events that require their immediate and undivided attention, such as breakdowns, and consequently every so often overlook their contractor paperwork.

A possible solution to this problem may lie in getting the Contractor Centre (CC) more involved. A single page spread sheet can be set up to encompass all the documentation needed for the contractor to enter ABC Concentrator and perform work. Should the contractor be due on-site, the Foremen can email the CC and inform them in a timely manner as to the planned arrival date. The CC then checks their database to see whether all the necessary paperwork is in order. The simple spread sheet is filled in with ticks and

crosses to indicate which documents are valid and which have expired. Upon receiving the spread sheet as feedback from the CC, the Foremen can now go abound ensuring the expired documentation is rectified and updated before the Contractors visits ABC Concentrator.

A.8.6.4 Supply Chain Management (Materials Management)

Min/max Levels and Picking Control It is recommended that the supply stores have a greater involvement in setting the Economic Order Quantity as well as the min/max levels of inventory to ensure that stock is not over-stocked unnecessarily. Although the Engineering department will have a better understanding of the min/max levels to set, the Supply Officer should be in charge of authorising changes to these levels based on both a reasonable motivation from engineering and a check of previous stock trends.

Furthermore, there needs to be better control over the pickings of stock. Currently, the Supply Officer prints out lists of picking requests and actual pickings and compares them to identify deleted entries. This is time-consuming and it is suggested that there be better control over who can delete pickings, as well as notification of when pickings are deleted. Requiring double authorisation for deletion of pickings from stores may prevent unethical behaviour in this regard.

A.8.6.5 Facilities, Tools and Workshops

Critical Spares Register It is recommended that a formal register of critical spares stored electronically which is updated regularly should be developed. The organization first needs to perform a Criticality Analysis on spare parts taking into account the down-time of a failure resulting in the need for that spare part, what is currently in stock, lead times of the parts and costs of the parts. This is necessary in order to determine what spare parts are truly critical. Tools and spare parts could also be tracked using tracking technology to prevent misplacements and to aid with managing spare parts around the plant.

Shadow Boards In order to improve stocktaking of tools it is recommended that shadow boards (boards on which tools hang with their outlines sprayed onto the board) should be introduced in all workshops. Currently, tools are merely stacked in a tool cupboard, but having shadow boards allow for easy identification of what tools are missing or currently being used.

Information Management As the business world moves ever closer to a completely collaborative model and competitors upgrade their capabilities, to remain competitive, the organization must improve their own business practices and procedures. They must

also increasingly share with their suppliers, distributors, and customers the critical in-house information that organizations once so aggressively protected. Furthermore, functions within the organization must upgrade their capability to generate and communicate timely and accurate information.

The Enterprise Resource Planning (ERP) provides two major benefits that do not exist in non-integrated departmental systems:

1. A unified enterprise view of the business that encompasses all functions and departments; and
2. An enterprise database where all business transactions are entered, recorded, processed, monitored, and reported.

This unified view increases the requirement for, and the extent of, interdepartmental cooperation and coordination through increased communication and responsiveness to all stakeholders. The ERP can also be used in any company that wants to enhance competitiveness by most effectively using all its assets, including information. This will enhance AAP efforts to achieve their AA GTS 20 objectives.

Within the ABC Concentrator context, there are a few problems relating to both incorrect usage and under utilization of the SAP. The Artisans are supposed to fill in the job cards which are then taken to Foremen and processed by the Planners or assistant–Planners. The Foremen and Planners should be able to identify mistakes which are currently being entered into SAP. Communication about the incorrect data entry issue is necessary with Foremen, Planners and personnel involved with SAP data entry.

SAP also has a Capacity Planning function which could be utilized to improve scheduling of jobs. It is suggested that there be a central workload server where all jobs can be easily scheduled and rescheduled. This will make it easier to reschedule tasks when breakdowns occur.

Use of handheld devices such as tablets may prove beneficial to completing jobs. The jobs, permits and lockout documentation, as well as the SLAM documentation could potentially be handled online via such devices.

Any ERP system requires continuous attention to maintain its effectiveness and operational performance. In order to continuously address the aForementioned characteristics, the organization / plant / operation needs to know what ERP success dependent factors to concentrate and expand on.

The most effective method of identifying most of these factors is through the analysis of the critical success factors of the general ERP implementation phase. These factors will most likely still be applicable on the operation and management of the system. From these success factors, possible reasons for failure can be identified. Therefore, armed with the knowledge of what makes an ERP system work and what severely affects it, one can efficiently manage it and utilize it.

A.8.6.6 Asset Care

Asset Prioritization / Criticality Analysis It is recommended that a risk criticality analysis be performed after which official risk management can be further documented. The CA for Supply Chain Management is the ability to prioritize the criticality of spares at the point of application to ensure optimized deployment of limited resources. Criticality must be defined by operations and must be aligned with that utilised by the maintenance discipline. Two Criticality analyzes should be performed, namely one for assets and one for spare parts.

- Criticality Analysis of Spare Parts – In terms of spare parts, criticality is determined based on three competency levels, namely Understanding, Competence and Excellence.

  For Understanding, spares criticality is determined with supply chain and follows a formal methodology with criticality calculated on:

  1. The estimated downtime per event;
  2. Lead times; and
  3. Cost of spares.

  For Competence, the equipment criticality is supplied to the supply chain by the maintenance department based on a structured risk versus consequence approach. Lead times and costs are provided by the supply chain. Stock levels are reported per criticality classification. The equipment criticality is reactively evaluated by the maintenance department based on work order downtime and cost analysis.

  Under the Excellence level of competency, equipment criticality is proactively reviewed annually and ratings are automatically determined and provided to the supply chain to update their spares criticality models.

- Criticality Analysis of Assets in Use – A CA in terms of Asset Care (Asset Prioritisation) involves a formal procedure of determining criticality of assets, often through a Failure Modes, Effects and Criticality Analysis .

  Failure Modes, Effects and Criticality Analysis is a methodology used to identify and analyze:

  – All the potential failure modes of the various parts of a system;
  – The effect these failures may have on the system; and
  – How best to avoid the failures, and/or to mitigate the effects of the failures on the system.

  The following questions should be asked to determine credible failure modes and their associated consequences:

- How can each part conceivably fail?
- What mechanics might produce these modes of failure?
- What could the effects be if the failure did occur?
- Is the failure in the safe or unsafe direction?
- How is the failure detected?
- What inherent provisions are provided in the design to compensate for the failure?

A Failure Modes, Effects and Criticality Analysis is a comprehensive process designed to identify potential significant and credible failure modes associated with equipment or systems being assessed. The failure mode describes how a system may fail and includes all possible causes ranging from operator errors, deficient management systems or strategies. The frequencies, as well as potential production downtimes or cost effects, associated with each of the identified failure modes are recorded. Furthermore, the likelihood of detecting these failure modes prior to actual failure are also documented.

A series of events usually needs to occur before a failure mode results in an effect, and therefore the complete series of events or scenario should be assessed. Following the identification of this series of events, the risk or criticality is quantified using the Risk Priority Number (RPN). The RPN of an asset is a number indicating the relative position of the asset to other assets in terms of criticality and, therefore, the position of the asset relative to the other assets for deserved attention.

In order to prioritize assets, the risk of each asset needs to be determined in terms of RPN . Equation A.1 displays the calculation of risk,

$$Risk = Likelihood \times Severity \tag{A.1}$$

where likelihood is the probability of failure and severity is the impact or consequence of failure. This risk can then either be multiplied by a Detection rating which indicates how difficult it is to determine failure is imminent or the risk can be left as is to form the RPN.

The failure probability of assets is determined through analysing the failure history recorded in the ERP system, consulting staff and Original Equipment Manufacturer (OEM) experience.

Practical considerations for a CA include:

- Inclusion of representatives from other departments that are involved with the criteria used to determine risk (i.e. the safety officer may provide a weighting for severity of failure of an asset based on safety concerns).
- The assets with highest RPNs are classified as A-critical assets and should be avoided as far as possible.

A.8.6.7 Comprehensive PAM Risk Management Strategy and Policy

A risk management programme should also be set up to include more Preventative and/or Predictive Maintenance. This will spare costs since it is well documented that Reactive Maintenance are far more expensive in the long-run than Preventative or Predictive Maintenance.

Quick Changeover: Part of the risk management strategy should be an assessment of Quick Changeover. Quick Changeover refers to the capability of maintenance or an operational change to occur with minimal impact on production. All elements required during a changeover for maintenance or an operational change are identified and then classified according to external tasks or internal tasks. External tasks are elements that can be performed without production equipment ceasing. Internal tasks are elements that cannot be performed without the production equipment being stopped. The production downtime is reduced by converting as many internal tasks as possible to external tasks.

Risk Plan with CA: The risk plan should also include a CA c once an Asset Register has been set up. The first step in criticality analysis involves defining the objectives and context for the assessment. Objectives focus on the assessment for specific impacts that may include any number of risks to the employees, the environment, production uptime or cost.

The risk plan should account for the types of failure modes and their probabilities of failure. Generally, the probability of failure of assets is classified into five categories, namely:

1. Certain
2. Almost certain
3. Probable
4. Unlikely
5. Almost impossible

Failure probability will vary as time passes and the tactics required to mitigate the risk should change accordingly. Figure A.21 displays the different types of failure curves that equipment can experience.

Figure A.21: Different Types of Failure Curves of Equipment

As can be seen in Figure A.21, there are six primary failure curves, namely Age-related, Bathtub, Fatigue-related, Initial Break-in, Random Failure, and Infant Mortality:

1. Age-related
   (a) Rapid increase in failures near end of life
   (b) Least common of all
   (c) Examples include impellers, crusher jaws, tracks and liners
2. Bathtub
   (a) High probability of failure at beginning and end of life
   (b) Example includes simple electromechanical systems
3. Fatigue-related
   (a) Steadily increasing probability of failure with age
   (b) Associated with corrosion and creep
   (c) Usually when equipment is in contact with product
   (d) Examples include pipes, tires, refractories, structures and clutches
4. Initial Break-in
   (a) Not age-related except at beginning of life
   (b) Examples include hydraulics, pneumatics and engines

5. Random Failures
   (a) Random; not age-related
   (b) Examples include complex electronic, electric and / or mechanical systems
6. Infant Mortality
   (a) Most common failure mechanism for complex equipment
   (b) Probability high at beginning of life and declines with age
   (c) Often caused by improper installation and / or design
   (d) Examples include electronics, avionics and highly complex or integrated equipment

The type of failure curve differs per asset type and this should be kept in mind during the CA. In order to establish the possible failure modes of assets and their sub-assemblies, it is required to first define the function and associated performance requirements of those assets and respective sub-assemblies. The procedure to develop a risk plan is summarised below.

Determining the Function Every physical asset has a function to perform. These are usually apparent and easy to define, unlike its sub-assemblies, which could have multiple functions.

Functions can therefore be categorized into:

1. **Primary Function:** This is main reason why the asset, or sub-assembly exists or was acquired. It is usually evident from its name.
2. **Secondary Function:** Equipment can have a number of secondary functions. Failure of these secondary functions might be as severe as primary function failure.
3. **Protective Function:** As processes and equipment increase in complexity, so do the ways in which they can fail, as well as the consequences of those failures. To mitigate potentially dire results, protective devices are often used. Typical Protective Functions include warning operators of abnormal conditions, automatically shutting down a piece of equipment and taking over a function that has failed.

Establishing Performance Requirements: Once the functions of assets and their sub-assemblies have been established, it is necessary to define the desired level of performance of these assets and their sub-assemblies. The overall purpose is to define a physical asset's maintenance requirements that are necessary for the asset to meet its objectives in its operational environment. It is important to note that identical assets in different operating environments or modes may have different performance requirements.

Performance standards may include:

1. Qualitative performance standards: to look acceptable.
2. Environmental: maximum CO2 emissions allowed.
3. Safety standards: adequate guarding to ensure that staff cannot be exposed to any moving parts.
4. Ergonomic standards: provide a working environment for the driver within acceptable vibration and noise levels.
5. Multiple performance standards: to heat up 500 kg of product X from ambient temperature to boiling point (125 degrees centigrade) in one hour.
6. Absolute standards: to contain liquid.
7. Variable performance standards: transport 170 t of ore from the opencast pit to the primary crushers at a speed of between 10 and 40 Km/h at incline gradients of up to 7 degrees.
8. Upper and lower limits: to load 20 +- 0.1 t of ore into a carriage at a minimum rate of 60 carriages an hour.

In most instances, equipment can deliver what is required of it with proper maintenance. Situations can, however, arise when what is required exceeds the capabilities of the physical asset. In these cases, no amount of maintenance will bring the asset performance to the desired level. In these cases, an alternative solution needs to be considered, such as asset modification or unit replacement.

Failure Mode Analysis: While many potential failure modes can be listed, only likely ones need to be considered. These include:

1. Failure Modes that have occurred on the same or similar equipment. Determined through individuals experience and captured history.
2. Failure Modes that are already part of your preventative maintenance plan or tasks.
3. Failure Modes that have not yet happened, but are considered possible because reliable knowledge.
4. Failure Modes of which the consequences are likely to be very severe.

It is recommended that failure modes should be described in sufficient detail, in order to select an appropriate Maintenance Tactic.

The Root Cause describes in simple terms what causes a failure. This is very useful as it will indicate what proactive measures and Maintenance Tactic(s) should be used to mitigate the respective risk. Knowing what types of failures can occur, and what their respective root causes are, it is possible to establish how this failure will be behave. This is to effectively identify which Maintenance Tactic will be the most appropriate.

Maintenance Tactics Selection: Depending on the gravity of the situation, the action taken might be any one or combination of tactics available, or might even warrant adding backup systems.

In some cases, the effort and cost associated might not be warranted by the failure severity.

A successful failure management plan must be:

1. Technically feasible;
2. Risk-effective; and
3. Cost effective.

If an operation decides that more requirements are needed to fully construct their failure management plan, they must include those requirements only if the additional requirements does not unnecessarily complicate the failure management plan.

Statutory requirements need to be considered when developing a maintenance plan. In many cases, maintenance plan requirements are coupled to specific time frames in which they need to be conducted. Therefore, it is necessary to establish all these requirements pertaining to that specific asset or sub-assembly, and schedule them along with other maintenance and tests that needs to be conducted. The most recent Mine Health and Safety Act(s) would be used to establish these requirements.

Optimization of Existing Preventative Maintenance Schedule Downtime is the time in which the plant is not available for production because of a need for maintenance or repair. Downtime can be caused by a breakdown of the plant or by a failure of electricity or some other supply, or by a shutdown period for preventive maintenance.

Preventive Maintenance usually consists of:

- Lubrication and Inspection; and
- Periodic Overhaul.

Lubrication and inspection periods should be detailed in the maintenance schedules provided in the product support package. Many plant items are designed so that this work can be done without downtime, with the plant still working. The overhaul periods for the plant should be also specified so that arrangements may be made for a shutdown period during which the plant may be disassembled, cleaned, worn parts replaced and finally reassembled.

It is essential that the technical instructions provided with the plant contain full instructions for preventive maintenance including the frequency of lubrication, grades

of lubricant inspection procedures, overhaul instructions (with illustrations) and spare parts lists. Maintenance instructions for overhaul should indicate which parts should be replaced at each overhaul, also instructions for the measurement and inspection of the parts, which have been replaced. Good parts can then be returned to the stores and worn parts can be disposed of.

The time taken for preventive maintenance, whether it is frequent lubrication and inspection or whether it is for overhaul, should be discussed with the vendor. If some doubts appear about the ability of the plant engineers to do this work within the predicted time then the necessary training must be provided. The procurement officer must always allow the plant engineer access to the technical information (manuals, etc.) to be provided by the vendor so that he can examine their usefulness to him.

Two of the most common maintenance metrics used for both PM and Predictive Maintenance are Mean Time Between Failures (MTBF) and Maintenance Free Operating Period (MFOP) where MFOP provides a more realistic manner of predicting failure probability.

Maintenance Free Operating Period (MFOP) The Mean Time Between Failures (MTBF)s is a metric where the time between failures is calculated as an average by dividing the total life span of the system by the number of failures. For simple cases where there is no trend in failures and times between failures approximate the average, this metric is acceptable. However, equipment often fails more regularly over time and when trends such as this are present, MTBFs is no longer appropriate.

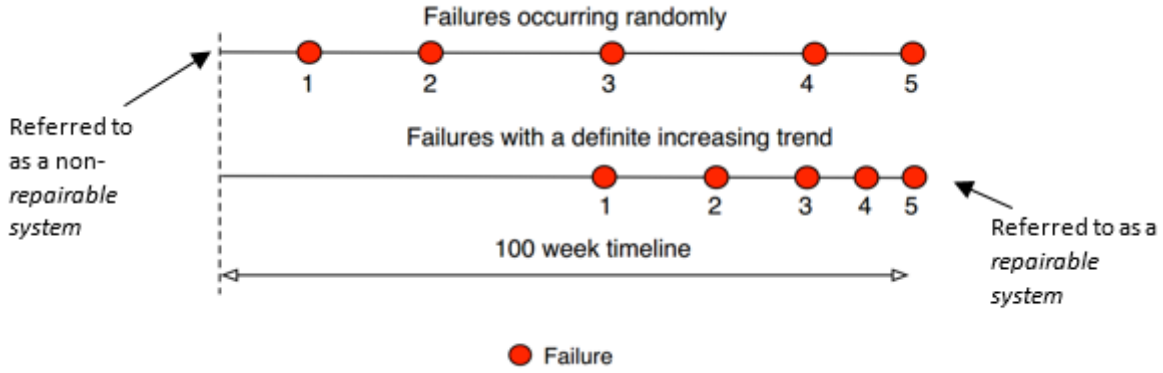


Figure A.22: Inappropriate application of MTBF (adapted from **?**)

Figure A.22 illustrates the scenario where MTBF would not be the meaningful metric to use. The first system is referred to as a non-repairable system while the second system is referred to as a repairable system. According to Van den Honert *et al.* (2013), a non-repairable system is a system that is discarded after its first failure on a system-level while a repairable system is one which can be restored to perform its function by any method other than complete replacement after its first failure on a system-level.

The repairable system in Figure A.22 clearly has an increasing trend. Using MTBF on such a system would be adequate in the initial stages, but eventually failures will occur more rapidly and sooner than the MTBF suggests. In this case, a model that is more appropriate for a repairable system is selected, often being a Non-homogenous Poisson Process as described by Van den Honert *et al.* (2013).

According to U (1999), the MFOP involves a period of operation during which an item will be able to operate without the operator being restricted in any way (due to system faults or limitations) with the minimum of maintenance. Mathematical models and failure statistics are used to determine the MFOP. The primary advantage of MFOP is that it tracks the behavior of the system through the life of the system. Therefore, MFOP is preferable over MTBF for repairable systems.

Total Productive Maintenance (TPM) TPM is a maintenance strategy where strong focus is placed on taking proper care of equipment. Maintainers and operational employees are brought together to figure out how to improve the Overall Equipment Effectiveness (OEE). OEE is a measure that indicates the percentage of planned production time that is truly productive. OEE is calculated as follows:

$$OEE = A \times P \times Q \tag{A.2}$$

where A is the percentage of availability (ratio of operating time over scheduled production time), P is the percentage of performance (ratio of theoretical production time over operating time) and Q is the percentage of quality (ratio of good units over total production units).

Appendix B

Marketing principles for the positioning of new brands

In the light of the fact the the PAMSEEM is not only a theoretical model to be used within the confines of a laboratory but a practical mechanism that should ultimately become part of the PAM organization's standard operating procedures and DNA the following principles used by marketing experts in the positioning of new brands and the launch of new products were considered.

1. *Ease of recognition*: In their analysis of brand awareness and brand attitude in marketing campaigns Percy & Rossiter (1992) describe brand awareness as being essential for the communications process to occur as it precedes all other steps in the process.

   > *"Without brand awareness occurring, no other communication effects can occur."*

   Percy & Rossiter (1992) are thus of the opinion that it would be impossible for a consumer to buy a brand they are not aware of it.

   During the development of the PAMSEEM a number of figures and tables, (collectively referred to for the purpose of this study as artefacts) are developed. These artefacts include:

   - Figure 6.2 – The PAMSEEM;
   - Figure 6.3 – The PAMSEEM purpose; and
   - Figure 6.8 – The Deadly Dectet Factors of PAMSEF

   With a full acknowledgement of the importance of brand awareness as well as the fact that organizational stakeholders are bombarded with communication on new management models and improvement fads, great care is taken to design artefacts that will be easy to recognize and the that will be meaningful in its own right.

2. *Simplicity and ease of use*: Organizations are introduced to new management models on a continuous basis. Many of these models are extremely valuable, but fail to deliver results because of their inherent complexity. During the design of the PAMSEEM the aim will be to find a compromise between the oversimplification of an extremely complex and involved process and the development and presentation of a mechanism that cannot be deployed within in the PAM organization because it is too complex and requires too many resources. With a full appreciation of this reality simplicity and ease of use are thus important principles that will be considered as part of the design criteria.

3. *Cultural neutrality*: Cultural diversity is often a key challenge organizations need to deal with, and although not included as one of the nine most recurring causes for SEF it is mentioned by a number of contributors (see Section 3.2.1). The issue of cultural diversity is however often mentioned in studies dealing with communication and marketing effectiveness (see De Mooij (2013); Peracchio *et al.* (2014) and Douglas & Craig (2011)). For this reason cultural neutrality is specifically considered during the design of the mechanism and the use of generally accepted and recognized concepts and analogies are considered and promoted. The characteristics of the screening and management of Cardio Vascular Diseases (CVD) and Strategy Execution Failure (SEF) is for example found to be remarkably similar and reference to the screening and management of CVD is made throughout this chapter.

4. *Quantitative analysis*: Despite the fact that organizational stakeholders often find the prospect of working with a quantitative model daunting, the screening and the determination of the relative importance of casual factors requires the completion of certain mathematical calculations. These calculations as well as the interpretation of the results were however simplified as far as possible to ensure that the completion of the screening model does not inhibit stakeholders to use the PAMSEEM.

Appendix C

Correspondece confirming the impact of the PAMSEEM

From: [redacted]@angloamerican.com
Subject: PAM Audit.
Date: 27 August 2015 at 7:52 AM
To: Johann Stimie jstimie@me.com

Hallo Johann and team,

This a quick note to thank you and your team for the contribution you have made to improve the effective management of assets at our concentrator. The intervention really contributed to higher levels of awareness regarding the impact, seemingly non related aspects can have on our success and performance.

Our asset management strategy is well-understood and communicated during all possible interactions. The fact that we included the operations guys in the process from the start really helps to break down the silo's that exist between engineering and operations. As you know this is an old plant and there are many issues that we still need to address, but you have left us with a set of tools that we could really use very effectively to implement our plans and strategies.

Kind Regards,

[redacted]
Engineering Manager
[redacted] Concentrator

[redacted]sis@angloamerican.com

Mobile: 083[redacted]2521
Work [redacted] 598 2408
Fax : 086[redacted]5666

From: [redacted]@angloamerican.com
Subject: Feedback
Date: 25 August 2015 at 10:45 AM
To: Johann Stimie jstimie@me.com

Hi Johann,

I hope you are well - I would just like to give you some feedback after your intervention here at Rustenburg concentrator. In that first interview I told you that I have three main problems:

1) The Head office guys want us to implement their strategy - but that the strategy is far too complex and that the guys on the ground just won't understand it. They just want to do their work.

2) The foremen are not using SAP as they should and that I was really frustrated with their lack of understanding and commitment to get involved during the maintenance planning process.

3) I also told you that the Ops. guys and the Eng. guys don't talk and that they are always playing the blame game - (which made my job very difficult).

Your intervention really gave me a foot to stand on because all of a sudden I was no longer a voice in the dessert. The findings of the study confirmed my opinion. The Rustenburg concentrator strategy we developed last year is really easy to understand and communicate to the guys and since you gave feedback and the conflict is in the open the guys are actually working together much better.

We are not totally out of the woods yet and the but we are moving in the right direction.

Thanks

Kind regards

[redacted]
PM Co-Ordinator
[redacted]Concentrators
Anglo Platinum
[redacted]598 2002
082 [redacted]6072

Appendix D

PAMSEEM screening feedback

"The silent killers"

Feedback regarding the screening of DDFs at the [redacted]

AngloAmerican

[redacted] concentrator screening feedback

Category	Screening factor	Weight	TPC	In Use	Maturity	Performance	TFS	Score	Risk
Direction	Strategy Formulation	20%	3.00	2	2	2	2.00	40%	
	Executors of Strategy	10%	1.50	4	3	2	0.90	60%	
Design	Organizational Design	15%	2.25	3	2	2	1.05	46%	
	Interdepartmental Relations	5%	0.75	4	3	2	0.45	60%	
	Management Control Systems	5%	0.75	3	2	2	0.35	46%	
	PAM System, Processes and Practices	20%	3	3	3	2	1.60	53%	
Interpersonal Processes	Communication	15%	2.25	3	2	2	1.05	46%	
	Change Management	2,5%	0.37	4	4	4	0.2	80%	
	Consensus and Priorities	2,5%	0.37	4	4	4	0.2	80%	
	Commitment	5%	0.75	3	3	3	0.45	60%	
	Total	100%					7.45	49.6%	

AngloAmerican

Interpretation of results

Score range	Interpretation guideline
0% - 50%	Immediate action is required irrespective of the relative importance of the DD Factor (DDF).
51% - 60%	Immediate action is required if the DDF carries a weight of more than 15%. If the DDF carriers a weight of less than 15\% the DDF should however still be closely monitored and if at all practical should be evaluated at least every three months.
60% - 75%	No immediate action is required except if this is the lowest scoring DDF and the organization has resources available. The DDF should however be closely monitored and evaluated at least every six to twelve months.
75% - 85%	No immediate action is required. Should be evaluated on an annual basis.
85% plus	No immediate action is required, and an indication of a very healthy state of affairs. Should be used as a benchmark and the conditions contributing to the score should be evaluated, to ensure repeatability.

AngloAmerican

Score interpretation and recommendations

Category	Screening Factor	Interpretation and Recommendation
Direction	Strategy formulation	It is strongly recommended that the organization should as a matter of urgency, invest time and resources to ensure the development of a Rustenburg concentrator specific PAM strategy.
	Executors of strategy	Senior managers are often straddled between strategic and operational responsibilities because lower level managers are not properly trained or does not have sufficient experience. This is serious problem but considering the resource limitations within the organization and the fact that there are factors that are considered to be more important, the organization should not attempt to address this problem in the next six to twelve months. The DDF should however be closely monitored and if the score does not improve as a result of action plans being implemented in other areas, a dedicated action plan to address the capacity of middle and first line management should be contemplated.

AngloAmerican

Score interpretation and recommendations (continue...)

Category	Screening Factor	Interpretation and Recommendation
Design	Organization design	Organization design is an important screening factor. The score is very low and immediate action is required. Long term sustainability is not possible within the context of a non-functional organizational structure. It is thus recommended that the underlying factors evaluated during the assessment of the OD should be evaluated in detail and that a detailed improvement plan (that may include Organizational re-design) should be formulated.
	Interdepartmental relations	Despite the relative low weight that Interdepartmental relations carries within this context the score is still relatively low. This score should be read in conjunction with the low score for OD. The steering committee however noted that effort of the executive management team to address the existing relationship dynamics. If the score does not improve as a result of action plans implemented to address OD aspects, a dedicated action plan to address Interdepartmental relations should be considered
	Management control systems	The score for this screening factor is very low. The development of action plans to improve management control will however be futile if an appropriate PAMS is not formulated. The development of a PAM scorecard as well as the implementation of a Plan--Do--Act feedback cycle should be considered as part of the development of the PAMS. The optimized use of the SAP system should also become an objective in the short to medium term. This factor need to be evaluated again in the next twelve months.
	PAM systems processes and practices	The organization should take note of the immature state of PSPPs. In addition to the fact that many PAM Processes and Systems have not been defined, those systems and processes that have been defined are not joined-up and are not aligned to the strategy. A detailed action plan to address this state of affairs need to be developed as a matter of urgency. It is also recommended that this factor is monitored closely and evaluated on a three monthly basis until such time that the score increase.

Score interpretation and recommendations (continue...)

Category	Screening Factor	Interpretation and Recommendation
Quality of Interpersonal Processes	Communication	Organizational communication is central to most processes including training, knowledge management and learning. The communication score is low and it is strongly recommended that the communication dynamics within the organization is evaluated in more detail. Based on the finding of the in-depth analysis an action plan should be developed to address communication inefficiencies.
	Change management	Evidence could be found of some change management tactics and practices currently being employed within the organization. Despite the fact that Change Management carries a relatively low weight the non-acceptance of these tactics as well as the non-performance of these tactics has a significant impact on the performance of a number of other screening factors. For this reason it is recommended that the organization investigates the effectiveness of Change Management tactics in far more detail. Specific cognizance should be taken of the cultural values of all stakeholders to ensure the use of appropriate Change Management tactics.
	Consensus and priorities	The PAMSEEM implementation process is consultative in nature and requires stakeholders to engage in continuous dialogue. For this reason there seem to be very high levels of consensus on priorities. The formulation of the PAMS will however also involve the setting of priorities. Against the backdrop of the relatively unhealthy Interdepartmental relationships that currently exist at the operational level it is however strongly recommended that this factor should monitored and evaluated on a three monthly basis.
	Commitment	It was noted that staff at the operational level seem to be generally disengaged. In the light of the fact that levels of engagement and commitment is a lagging indicator and with full cognizance that a number of action plans will be developed that might have an impact on staff engagement and commitment levels immediate action regarding this screening factors is not recommended. It is however strongly recommended that Commitment levels should be monitored and evaluated on a three monthly basis.

Appendix E

Examples of documents and outputs developed during the implementation of action plans at the ABC concentrator

[redacted] Concentrators PAM

Strategy

2015 -2017

AngloAmerican

[redacted] Concentrators' Strategy (2015 -2017)

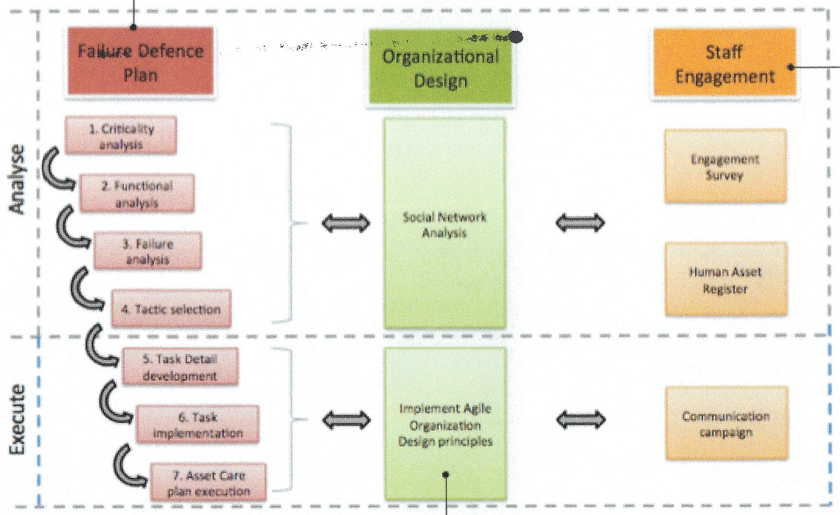
Vision

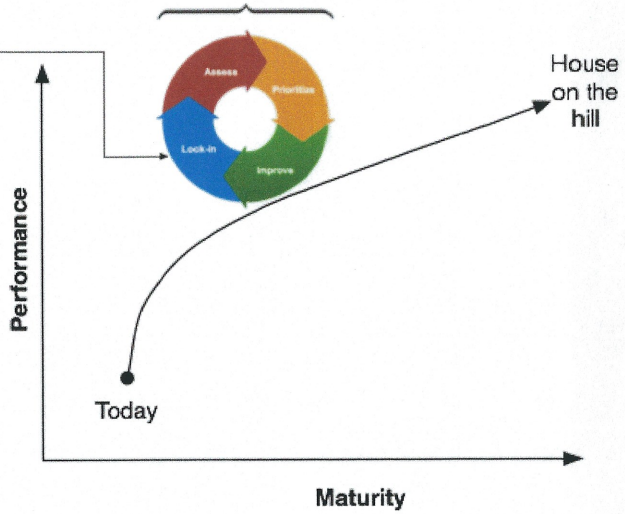
[redacted] Concentrators' PAM vision is to achieve PAM maturity and performance through the relentless pursuit of the Assess – Prioritize – Improve – Lock-in cycle, on all levels.

In the pursuit of these objectives the following principles will be adhered to:
(1) Environmentally and socially responsible operations;
(2) Cost effectiveness; and
(3) Compliance to Shareholder standards and protocols.

Strategic Objectives

Year	Safety	PM Ratio	Plant Availability
2015	Maintain Zero LTI/Injury Free Days	60/40	90%
2016	Maintain Zero LTI/Injury Free Days	70/30	92%
2017	Maintain Zero LTI/Injury Free Days	80/20	94%





Centers of Excellence

1) Work Planning and Control
2) Defect Eliimination
3) Condition Monitoring
4) Shutdown Management
5) Criticality Analysis

AngloAmerican

The Aim of this Document

The aim of this document is to define and document the Asset Management Strategy for Anglo American Platinum's [redacted] Concentrators.

To guide the settings of its asset management objectives, and to describe the role of the asset management systems in meeting these objectives. This includes the structure, roles and responsibilities necessary to establish the asset management systems and to operate it effectively.

The document details the Concentrator's Vision for assets and the practical three roadmap of activities in order to reach these objectives, ultimately achieve sustainable operational excellence.

This document was developed in alignment with the recommended practice, AA RP-020100 as defined within the Anglo American Group Asset Management Standard (AA GTS 020) and International Standard ISO 55000.

AngloAmerican

Vision

The [redacted] Concentrators' PAM vision is to achieve PAM maturity and performance through the relentless pursuit of the Assess – Prioritize – Improve – Lock-in cycle, on all levels.

In the pursuit of these objectives the following principles will be adhered to:
(1) Environmentally and socially responsible operations;
(2) Cost effectiveness; and
(3) Compliance to Shareholder standards and protocols.

AngloAmerican

Values

Our values for asset management is aligned with Anglo American Group Values and these are:

- Safety
- Integrity
- Innovation
- Accountability
- Care and Respect
- Collaboration

To enable us to live out these values, will require a broad understanding of Asset management principles and best practices and a full commitment to apply them. This commitment is expected from every individual at the Concentrator.

We believe that, by living out the Anglo Platinum Values, the following principles will be clearly visible within the [redacted] Concentrator:

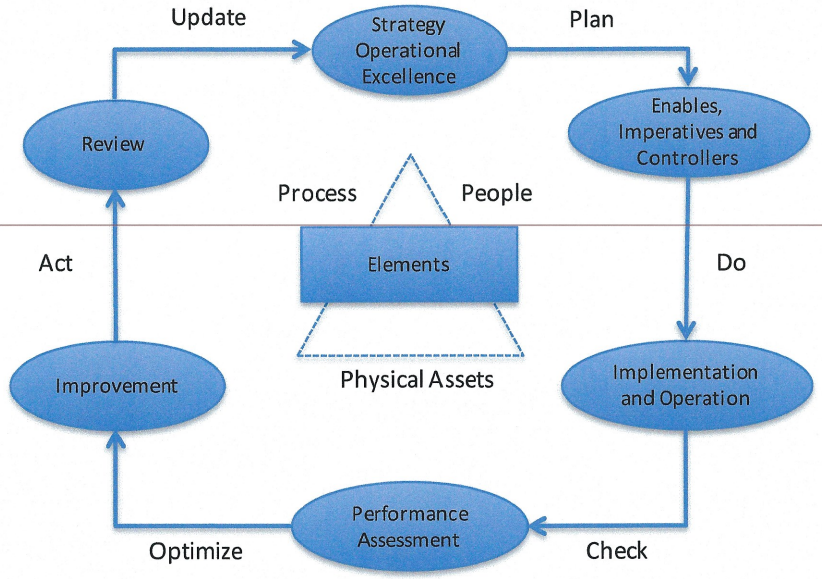
Maintenance of the safety and health of all our people
Fostering trust among and respect for all employees
Development of our people
Preservation of the environment
Responsibility towards communities
Wealth creation for all stakeholders
Honesty in the conduct of our business
Safeguarding our assets

AngloAmerican

Asset Management Philosophy

[redacted] Concentrator's Asset Management Philosophy is based Anglo American Asset Management Standard (AA-GTS 020) as well as the International Standard (ISO 55000).

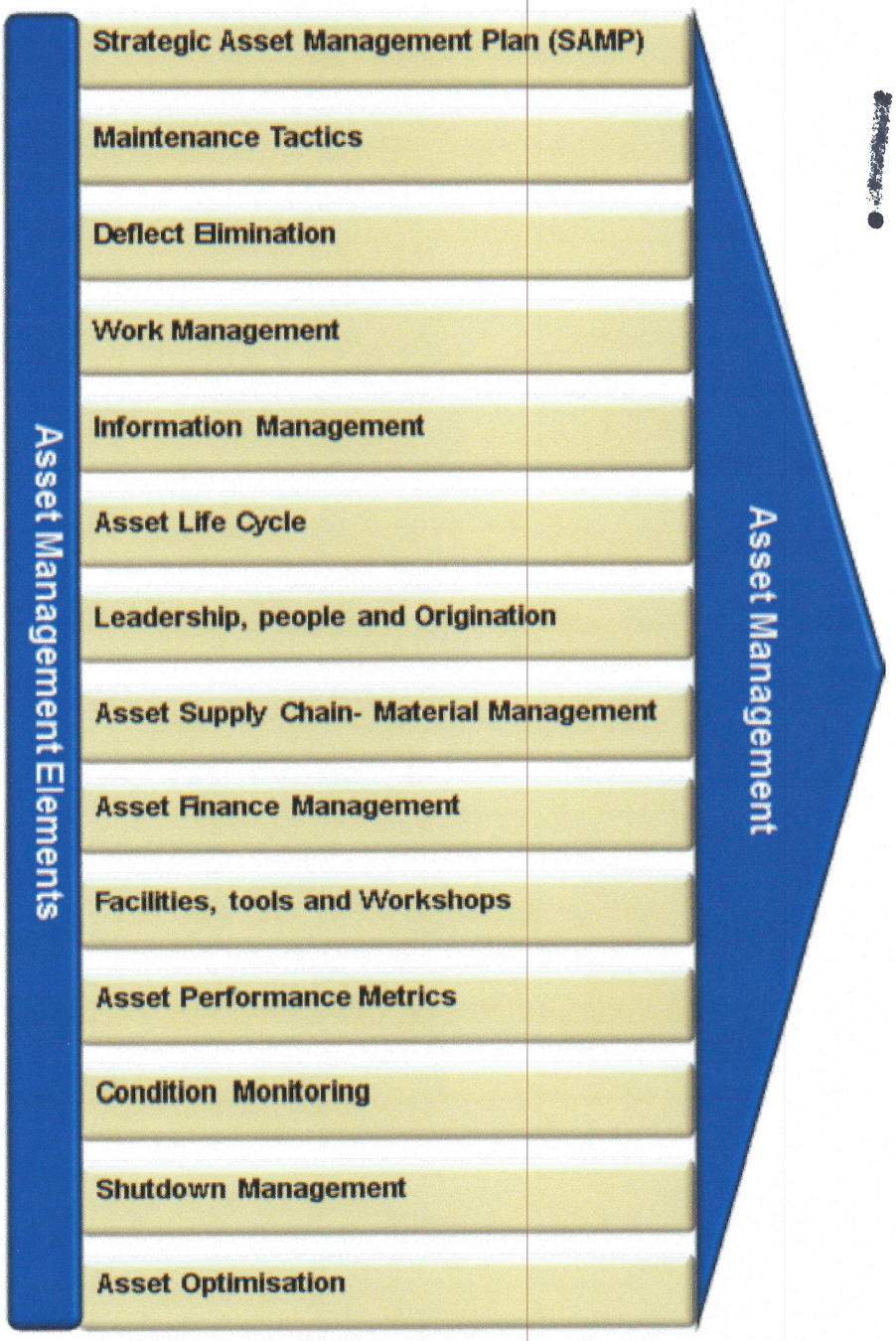
The Standard also addresses the interfaces of physical asset management, with business enablers such as Finance, Supply Chain Management and Leadership People & Organisation, and is depicted by the diagram below:



Anglo American Group Technical Standard that defines the minimum requirements for Asset Management in Anglo American.
The Standard targets the production value chain, focusing on physical asset management over its complete life cycle. Its objective is to sustainably optimise integrated equipment maintenance and production-related activities.

Asset Management Elements

The Asset Management Elements to maximise effectiveness by addressing 14 pillars or principles.



Strategic Objectives

[redacted] Concentrator's Strategic Asset Management Plan is based on the Anglo American Asset Management Standard (AA-GTS 020) as well as the International Standard (ISO 55000). The Standard also addresses the interfaces of physical asset management, with business enablers such as Finance, Supply Chain Management and Leadership People & Organisation.

The table below indicates the key areas that the [redacted] Concentrator Management Team identified as the areas that they want to focus on in order to achieve the Asset Management Mission.

Year	Safety	PM Ratio	Plant Availability
2015	Maintain Zero LTI/Injury Free Days	60/40	90%
2016	Maintain Zero LTI/Injury Free Days	70/30	92%
2017	Maintain Zero LTI/Injury Free Days	80/20	94%

AngloAmerican

Action Plan

The improvement plan is represented below in the form of the "Strategy on a Page" model.
In order to ensure the successful implementation of this Asset Management Strategy all [redacted] Concentrator employees and contractors must undertake to:

Comply with the defined [redacted] Concentrator business processes and best practices, thereby ensuring that [redacted] Concentrator and subsequently the Anglo Group data is correct and effectively used to assist in the effective maintenance management of our assets.
Maintain and operate the plant in the safe manner for which they were designed, in compliance with all legal requirements, where preventative maintenance or predictive maintenance takes precedence over all other forms of maintenance.
Focus our activities on the reduction of major losses associated with breakdowns, reduced speed, idling, minor stoppages, reduced yield, set-up losses and adjustment losses (where applicable).
Perform all activities in a cost effective manner by using the correct tools and procedures and appropriate manpower skills while at all times complying with the legal requirements and adhering to [redacted] Concentrator and Anglo American Platinum standards and COP's
Promote asset care through the employment of a competent work force.

Provide Business Centred Management and related training for all staff and review needs

AngloAmerican

[redacted] Concentrators' Strategy (2015 -2017)

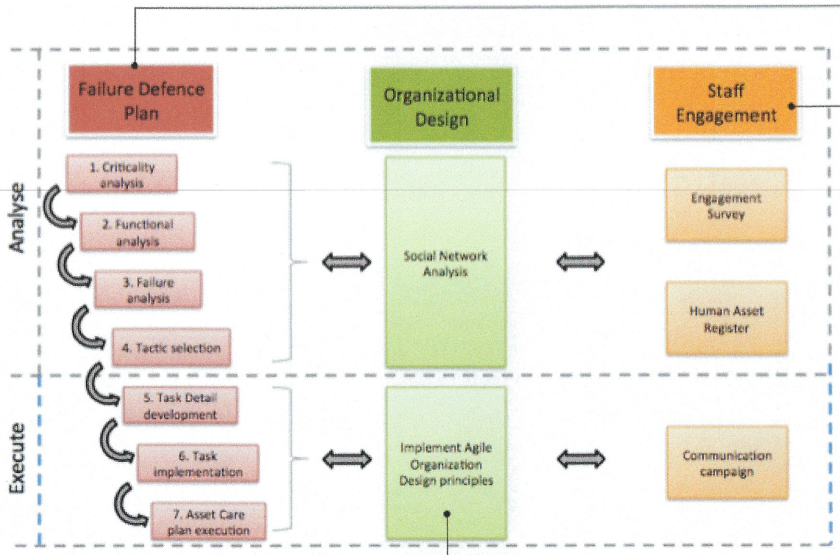
Vision

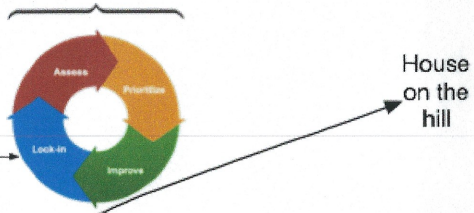
The [redacted] Concentrators' PAM vision is to achieve PAM maturity and performance through the relentless pursuit of the Assess – Prioritize – Improve – Lock-in cycle, on all levels.

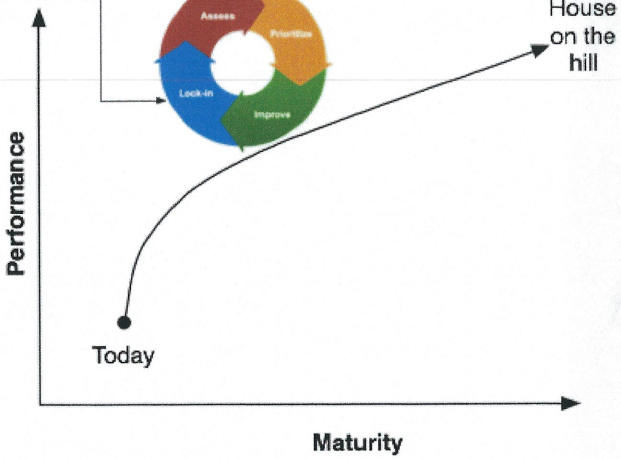
In the pursuit of these objectives the following principles will be adhered to:
(1) Environmentally and socially responsible operations;
(2) Cost effectiveness; and
(3) Compliance to Shareholder standards and protocols.

Strategic Objectives

Year	Safety	PM Ratio	Plant Availability
2015	Maintain Zero LTI/Injury Free Days	60/40	90%
2016	Maintain Zero LTI/Injury Free Days	70/30	92%
2017	Maintain Zero LTI/Injury Free Days	80/20	94%







Centers of Excellence

1) Work Planning and Control
2) Defect Eliimination
3) Condition Monitoring
4) Shutdown Management
5) Criticality Analysis

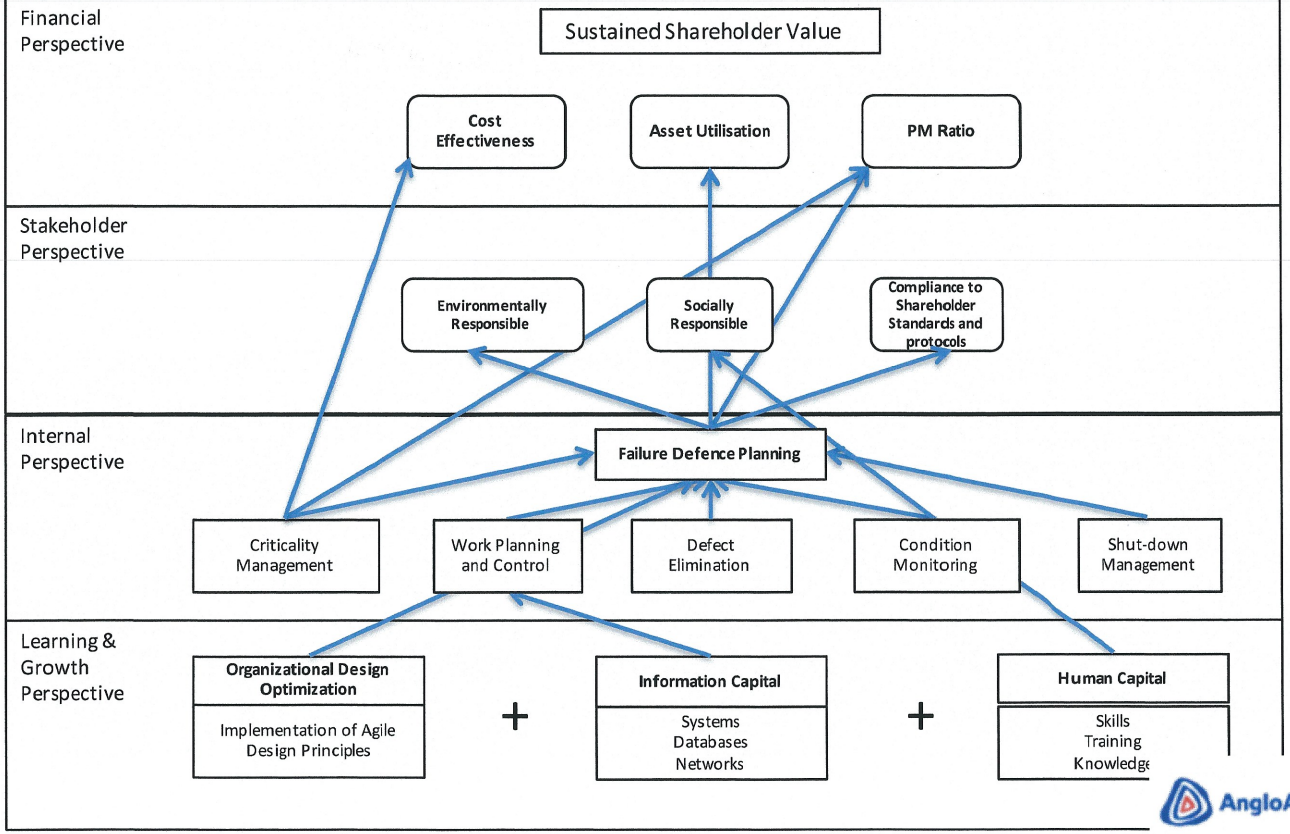
AngloAmerican

[redacted] Concentrators' Scorecard

Vision:

The [redacted] Concentrators' PAM vision is to achieve PAM maturity and performance through the relentless pursuit of the Assess – Prioritize – Improve – Lock-in cycle, on all levels.

In the pursuit of these objectives the following principles will be adhered to:
(1) Environmentally and socially responsible operations;
(2) Cost effectiveness; and
(3) Compliance to Shareholder standards and protocols.



AngloAmerican

Quick wins

Team 1:

- Standby units are available
- Hand held condition monitoring done by artisans
- 100% shutdown jobs completed

Team 2:

- Develop critical task inventory
- Develop available of spares inventory
- Artisan create maintenance plans of the equipment

Team 3:

- Stop duplication of Job Cards
- Ensure availability of spares
- Deploy people to ensure the optimal utilization of people

Team 4:

- Install a pneumatic drain valve

Team 5:

- Capture correct data on SAP
- Capture data on time
- Proper inspections
- Standby units
- Proper walk about by supervisors before end of shift to ensure availability

AngloAmerican